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STUDIES ON THE INTERSPECIFIC RELATIONSHIP BETWEEN GOBIID FISH AND SNAPPING SHRIMP. I. GOBIID FISHES ASSOCIATED WITH SNAPPING SHRIMPS IN JAPAN[1)]

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With Text-figures 1–23, Tables 1–14 and Plates I-III

Some species of the gobiid fishes are known to utilize burrows dug by the alpheid shrimps on sandy and muddy bottoms as the nest and the shelter and live in close association with them. These two animals have generally developed a tactile "alarm system," that is, the shrimp is always touching the gobiid fish staying near the en-entrance of the burrow by one of its antennae outside the burrow, and feels the goby's quivering motion of the caudal part in face of an unusual situation to do quick withdrawing reaction into the burrow. This association was closely observed by Luther (1958) and Magnus (1967) in the Red Sea. In Japan, Harada (1969, 1972) reported four species of the gobiid fishes associated with two species of the shrimps from the shallow water of Tanabe Bay and the Nansei Islands. Recently, these associations have been paid more attentions by several workers in the tropical and subtropical waters and it has been revealed that the species of the gobiid fishes and the snapping shrimps taking part in the association are unexpectedly numerous and range on various sorts of sediments from the intertidal zone to a depth more than 50 m (Klausewitz, 1974a, 1974b; Polunin et Lubbock, 1977). On the southern coast of Japan, more than 20 species of the gobiid fishes have been confirmed to inhabit the burrows of the shrimps by my diving observation.

As for the snapping shrimps, more than ten species are presumed to be making assocation with the gobies in Japanese waters, but only a part of them have been so far caught, because of extreme difficulty of collecting.

In this paper, the descriptions of 20 species of gobiid fishes hitherto collected in Japan (three species of *Cryptocentrus*, three of *Mars*, three of *Vanderhorstia*, one of *Ctenogobiops*, one of *Tomiyamichthys*, six of *Amblyeleotris*, one of *Mahidolia*, one of *Acentrogobius* and one of *Vireosa*), including five new species, are given and their distributions and habitats are recorded. The taxonomical positions of these species are also considered. Three types of *Amblyeleotris japonica*, which were described as the geographical variations in my previous paper (Yanagisawa, 1976), are assigned to

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three distinct species. *Cryptocentrus filifer*, *Acentrogobius pflaumi* and *Vireosa hanae*, all well known species in Japan, are given their descriptions at full length, since some characteristics are newly examined to compare with other species. One undescribed species, collected from Shirahama and mentioned in my latest paper (Yanagisawa, 1977) as having the closest affinities with *Cryptocentrus* is not mentioned in this paper, because Drs. D.F. Hoese and J.E. Randall are preparing the description of this species (Hoese, personal communication).

Materials and Methods

The observations and collections were carried out on the southern coast of Japan (Table 13) from October 1972 to August 1977 by SCUBA diving and snorkeling. Counting and measuring of the specimens were made in the following ways. The number of scales in a longitudinal series was counted from the upper edge of pectoral base to caludal base and that in a transverse series was counted obliquely from the origin of anal fin to the middle part of second dorsal base. Pectoral fin rays were counted on both sides, and pectoral length was measured from the middle of the inner base to the tip of the longest ray. "First dorsal fin length," "second dorsal fin length," "anal fin length" and "pelvic fin length" express the length of the respective longest ray. The length of uniting membrane of pelvic fins was measured along its median line, and the relative length of this to the longest pelvic ray was calculated and designated as UM-value. The number of gill-rakers was calculated only for the lower limb of the first gill arch when those on the upper limb are rudimentary.

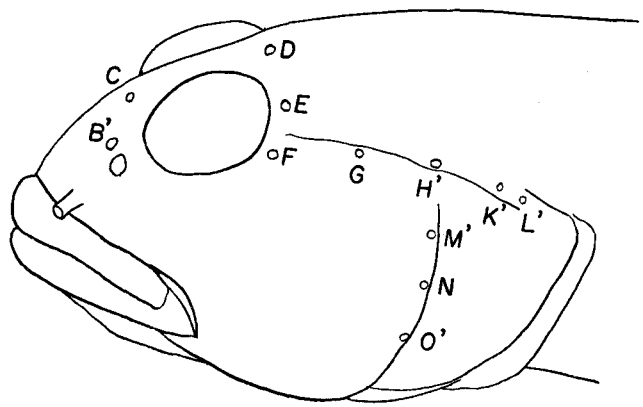

Fig. 1. Names of canal pores. B′-H′, pores of anterior oculoscapular canal; K′-L′, pores of posterior oculoscapular canal; M′-O′, pores of preopercular canal; ′, pores at tip of canal.

All other counts and measurements were made using the standard methods of Hubbs and Lagler (1958). Measurements are expressed in thousandths of standard length as proportional measurements. The names of canal pores on head are given as alphabetical letters designated by Prince Akihito and Meguro (1974, 1977) (Fig. 1),

and the number of specimens examined and that of specimens having the pore are written in a parenthesis. Teeth and gill-rakers were examined after being stained by alizarine-red, if necessary. All the specimens examined whose collectors' names are not specified were caught by myself.

The specimens are deposited at the Seto Marine Biological Laboratory of Kyoto University and the Department of Biology, Ehime University.

Key to the Genera Associated with the Snapping Shrimps

Twenty species hitherto collected in Japan are referable to nine genera. The key to these genera can be given as follows.

a. Second dorsal fin with less than 20 soft rays.
  b. Scales in a longitudinal series more than 50.
    c. Uniting membrane and frenum of pelvic fins normally developed.
      d. Cheeks plump, their dorsal margins coming close each other at occipital region. .....V. *Tomiyamichthys*
      d′. Cheeks not plump as above.
        e. Sensory papillae on head fairly well developed. Caudal fin as long as head. .....II. *Mars*
        e′. Sensory papillae on head poorly defined. Caudal fin as long as or longer than head.
          f. Scales in a longitudinal series more than 65. .....I. *Cryptocentrus*
          f′. Scales in a longitudinal series less than 65.
            g. Caudal fin lanceolate, longer than head. .....III. *Vanderhorstia*
            g′. Caudal fin rounded, as long as head. .....IV. *Ctenogobiops*
    c′. Uniting membrane of pelvic fins rudimentary or not fully developed, and pelvic frenum redimentary or absent. .....VI. *Amblyeleotris*
  b′. Scales in a longitudinal series less than 50.
    c. Gill-opening wide, exceeding a point below posterior margin of preopercle. .....VII. *Mahidolia*
    c′. Gill-opening not or only slightly extending forward below. .....VIII. *Acentrogobius*
a′. Second dorsal fin with more than 20 soft rays. .....IX. *Vireosa*.

Descriptions

I. *Cyptocentrus* Valenciennes

(Cuvier et Valenciennes, 1837, p. 111)

Smilogobius Herre, 1934, p. 88.

Body elongate, compressed, head roundish. Scales more than 65 in a longitudi-

nal series, ctenoid posteriorly, cycloid anteriorly, or all cycloid. Head naked, the median part of nape naked or covered with small scales. Interorbital space very narrow. Snout obtuse, as long as or slightly longer than eye diameter. Mouth oblique, upper jaw reaching to a point below the middle part of eye or more. Teeth on both jaws in several series, the outer enlarged. The outer series on lower jaw extends to the middle of an inner band, the last tooth mostly recurved canine-like on each side. Tongue rounded or truncate. Gill-opening wide, extending a little beyond the anterior part of opercle. Sensory papillae on head poorly defined. Dorsal fin-rays VI-I, 9 to 20; anal fin-rays I, 9 to 21. Pelvic fins united. Caudal fin pointed, longer than head.

a. Anal soft rays 10 or 11. .....1. *C. singapurensis*
a′. Anal soft rays 9.
b. No transverse bands on body. .....2. *C. flavus*
b′. Several transverse bands on body. .....3. *C. filifer*

1. *Cryptocentrus singapurensis* (Herre)

(Japanese name: Oiran-haze)

(Pl. I-A)

Smilogobius singapurensis Herre, 1936, p. 13, pl. 10.
Smilogobius singapurensis Koumans, 1953, p. 26, fig. 4.
Smilogobius singapurensis Masuda, Araga et Yoshino, 1975, p. 276, pl. 91-L.

Material examined: Fourteen specimens from the head of Kabira Bay, Ishigaki Island, Nansei Islands, mud bottom, lower intertidal zone to 1.5 m depth, 14 and 15 February 1973, collected by Y. Yanagisawa; 11 July 1973, collected by C. Araga and T. Yoshino.

Description

Counts and proportional measurements are shown in Table 1. Dorsal fin-rays VI-I, 9 to 11; anal fin-rays I, 10 or 11; pectoral fin-rays 16 to 18; vertebrae 10+16= 26; gill-rakers on lower limb of first arch 9 to 11; scales 71 to 89 in a longitudinal series, 24 to 29 in a transverse series.

Head roundish, somewhat bulbous, body elongate subcylindrical anteriorly and compressed posteriorly. Interorbital space very narrow; snout obture, about 1.4 times as long as eye diameter; anterior nostril with a short tube positioned close to lip, posterior nostril without rim positioned about halfway between the anterior margin of eye and anterior nostril. Mouth slightly oblique; jaws subequal and upper jaw reaching to a point below the posterior part of eye. On upper jaw a single external series of about 10 teeth, a few of which in front canine-like on each side, and an inner band of several irregularly arranged series of small teeth. On lower jaw an inner band of small teeth, several series in front and two series posteriorly, and an outer series of about 10 pointed teeth extending to the middle of an inner band on each side, its terminal tooth enlarged and canine-like (Fig. 8–A). Teeth on both

Table 1. Counts and proportional measurements of *Cryptocentrus singapurensis* and *C. filifer*. Proportional measurements are expressed in thousandths of standard length. Average is shown in a parenthesis and the number of specimens in a bracket.

	Cryptocentrus singapurensis		*Cryptocentrus filifer*
Number of specimens	9	5	6
Sex (♀+♂)	female	male	2+4
Standard length (mm)	58.6–76.2 (65.5)	60.9–81.7 (69.7)	48.8–78.1 (65.4)
Total length	1283–1391 (1300)	1290–1312 (1300)	1304–1330 (1322)
Body height	172– 198 (189)	187– 195 (190)	170– 194 (181)
Head length	259– 300 (289)	273– 283 (276)	289– 305 (297)
Eye diameter	59– 67 (63)	57– 64 (59)	60– 87 (69)
Interorbital width	10– 17 (13)	14– 16 (15)	6– 16 (11)
Snout length	84– 98 (92)	74– 86 (81)	59– 77 (65)
Caudal peduncle length	136– 157 (149)	141– 156 (152)	154– 188 (174)
Caudal peduncle height	97– 104 (101)	100– 108 (103)	79– 90 (85)
First dorsal fin length	210– 261 (230)	228– 292 (269)	346– 553 (468)
Second dorsal fin length	178– 200 (187)	200– 223 (211)	151– 188 (177)
Second dorsal fin base	282– 312 (301)	302– 330 (312)	279– 305 (286)
Anal fin length	172– 198 (184)	171– 218 (195)	182– 208 (198)
Anal fin base	237– 260 (250)	248– 290 (266)	210– 221 (211)
Pectoral fin length	212– 250 (224)	215– 233 (222)	212– 242 (224)
Pelvic fin length	207– 237 (220)	233– 268 (253)	199– 218 (208)
Predorsal length	342– 372 (355)	343– 353 (347)	361– 389 (371)
Presecond dorsal length	541– 570 (556)	540– 573 (556)	567– 586 (576)
Prepelvic length	307– 343 (330)	297– 330 (317)	321– 354 (332)
Preanal length	589– 640 (616)	581– 605 (594)	596– 646 (617)
Dorsal fin rays	VI-I, 9[1], 10[8]	VI-I, 10[4], 11[1]	VI-I, 10[6]
Anal fin rays	I, 10[9]	I, 10[3], 11[2]	I, 9[6]
Pectoral fin rays	16[2], 17[10], 18[6]	16[2], 17[8]	17[1], 18[8], 19[3]
Scales in longitudinal series	71– 89 (79)	76– 86 (80)	80– 101 (89)
Scales in transverse series	24– 29 (27)	26– 27 (27)	23– 29 (27)

jaws are hidden, more or less, by a dense papillate fringe lining each of lips. No teeth on vomer; the frontal part of vomer noticeably protruding downward. Tongue rounded, glossohyal bone narrow fan-shaped. Gill-opening wide, extending to a point below the anterior part of opercle; isthmus moderate; no fleshy flap on the inner margin of shoulder girdle. No spine on preopercle. Canal pores and sensory papillae on head are shown in Fig. 3-A. Anterior oculoscapular canal with pores B′(7/7), C(7), D(7), E(7), F(7), G(7), H′(7); posterior oculoscapular canal with pores K′(7), L′(7); preopercular canal with pores M′(7), N(6), O′(7). Sensory papillae on head not remarkable.

First dorsal fin higher than body, 3rd or 4th spine longest. Second dorsal fin as high as body or slightly higher than body. Anal fin as high as second dorsal fin, its origin at a point below 2nd soft ray of second dorsal fin. Caudal fin oblong, as

long as head. Pectoral fin without silky free rays, rounded posteriorly, nearly reaching to a line vertically through the origin of second dorsal fin. Pelvic fins I, 5, both fins united, uniting membrane and frenum normally developed. First and second dorsal fins, anal fin and pelvic fins in male longer than in female.

Scales on body all small cycloid. Head naked, the median part of nape, pectoral base and thorax scaleless. Belly scaly.

Colour of body creamy with 7 or 8 reddish brown transverse bands running a little obliquely downawrd and forward. Head and nape ornated with red spots and short bars. In male, dorsal fins with red spots, and a red stripe along their distal edge; anal fin dark blue at the distal half with a blue longitudinal stripe at the distal part. In female, detailed colourlation of dorsal fins and anal fin unknown, but there may be sexual differences in their colourlation. Pectoral fins and caudal fin pale. Pelvic fins olive with longitudinal reddish bands.

2. *Crytocentrus flavus* n. sp.

(Japanese name: Kogane-haze)

(Fig. 2, Pl. 1-B)

Smilogobius sp. Masuda, Araga et Yoshino, 1975, p. 277, pl. 91-M.

Holotype: SMBL Type-290, adult male, 38.8 mm, head of Kabira Bay, Ishigaki Island, Nansei Islands, mud bottom, 1 m depth, 11 July 1973, collected by C. Araga, T. Yoshino.

Paratypes: SMBL Type-291, adult female, 36.4 mm, same locality and date as holotype, collected by C. Araga and T. Yoshino. SMBL Type-292, young, 19.4 mm, Sakieda, Ishigaki Island, sandy mud bottom, 3 m depth, 15 February 1973.

Descrpition

Counts and proportional measurements are shown in Table 2. Dorsal fin-rays VI-I, 10; anal fin-rays I, 9; pectoral fin-rays 16 or 17; vertebrae 10+16=26; gill-rakers on lower limb of first arch 9; scales 67 to 71 in a longitudinal series, 26 to 28 in a transverse series.

Head roundish, body elongate, compressed. Interorbital space very narrow;

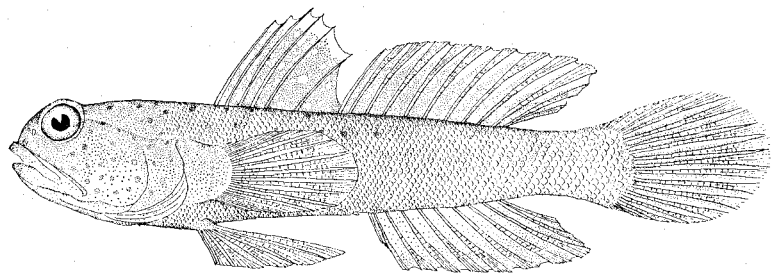

Fig. 2. *Cryptocentrus flavus* n. sp., Paratype SMBL Type-291, female, 36.4 mm in standard length.

Table 2. Counts and proportional measurements of *Cryptocentrus flavus*. Proportional measurements are expressed in thousandths of standard length.

	Holotype SMBL 290	Paratypes	
		SMBL 291	SMBL 292
Sex	♂	♀	young
Standard length (mm)	38.8	36.4	19.4
Dorsal fin rays	VI-I, 10	VI-I, 10	VI-I, 10
Anal fin rays	I, 9	I, 9	I, 9
Pectoral fin rays	16–16	16–17	17–16
Scales in longitudinal series	70	71	67
Scales in transverse series	27	28	26
Total length	1284	1302	1320
Body height	214	225	222
Head length	307	305	371
Eye diameter	75	74	94
Interorbital width	15	16	10
Snout length	77	74	67
Caudal peduncle length	175	143	186
Caudal peduncle height	111	121	103
First dorsal fin length	209	214	186
Second dorsal fin length	193	176	160
Second dorsal fin base	294	297	268
Anal fin length	191	192	206
Anal fin base	222	217	211
Pectoral fin length	278	266	284
Pelvic fin length	237	242	263
Predorsal length	348	360	361
Presecond dorsal length	557	549	541
Prepelvic length	325	332	330
Preanal length	626	624	608

snout obtuse, as long as eye diameter; anterior nostril with a short tube positioned close to lip, posterior nostril without rim positioned about halfway between the anterior margin of eye and anterior nostril. Mouth slightly oblique; jaws subequal and upper jaw exceeding a point below the posterior end of eye. On upper jaw an outer series of several larger teeth on each side and an inner band of several irregularly arranged series of small teeth. On lower jaw an inner band of several series of small teeth and an outer series of about 8 pointed teeth extending to the middle of an inner band on each side, its terminal tooth canine-like. Teeth on both jaws are hidden, more or less, by a dense papillate fringe lining each of lips. No teeth on vomer; the frontal part of vomer noticeably protruding downward. Tongue rounded, glossohyal bone narrow fan-shaped. Gill-opening very wide, extending to a point below about halfway between the posterior margin of eye and the anterior margin of opercle; isthmus narrow; no fleshy flap on the inner margin of shoulder girdle. No

spine on preopercle. Canal pores and sensory papillae on head are shown in Fig. 3-B. Anterior oculoscapular canal with pores B′(3/3), C(3), D(2), E(3), F(3), G(3), H′(3); posterior oculoscapular canal with pores K′(3), L′(3); preopercular canal with pores M′(3), N(2), O′(3). Sensory papillae on head very poorly defined. First dorsal fin slightly lower than body height, 2nd to 5th spine longest. Second dorsal fin lower than body height. Anal fin as high as second dorsal fin, its origin at a point below 2nd soft ray of second dorsal fin. Caudal fin rounded, as long as head length. Pectoral fin without silky free rays, rounded posteriorly, reaching a line vertically through the origin of second dorsal fin. Pelvic fins I, 5, both fins united, uniting membrane and frenum normally developed.

Scales on body all small cycloid. Head naked, the median part of nape, pectoral base scaleless. Thorax and belly scaly.

Colour of body yellow with a lot of small blue spots on head and the anterior half of body. First dorsal fin yellow with many light blue spots. Second dorsal fin yellow with light blue spots on the basal half and transverse stripes of the same colour on the distal half. Anal fin and pelvic fins yellowish with transverse stripes and small spots of light blue respectively. Pectoral fins and caudal fin yellowish.

Remarks

This species can be distinguished from other *Cryptocentrus* species by the small number of scales (67–71) and its characteristic colourlation; whole the body and fins yellowish with light blue spots. Transverse bands on body, which are recognized in most of the species of this genus, are absent in this species.

3. *Cryptocentrus filifer* (Valenciennes)

(Japanese name: Itohiki-haze)

(Pl. I-C)

Gobius filifer Valenciennes, in Cuvier et Valenciennes, 1837, p. 106.
Gobius knutteli Bleeker, 1858, p. 16, pl. 1, fig. 2.
Cryptocentrus filifer Jordan et Snyder, 1901, p. 72, fig. 12.
Cryptocentrus filifer Jordan, Tanaka et Snyder, 1913, p. 349, fig. 301.
Cryptocentrus filifer Herre, 1927, p. 241.
Cryptocentrus filifer Tomiyama, 1936, p. 82.
Cryptocentrus filifer Koumans, 1953, p. 86, fig. 17.
Cryptocentrus filifer Matsubara, 1955, p. 835.
Cryptocentrus filifer J.L.B. Smith, 1959, p. 193, pl. 13-D.
Cryptocentrus filifer Masuda, Araga et Yoshino, 1975, p. 277, pl. 91-0.

Materials examined: Six specimens from Shirahama, Wakayama Prefecture, mud bottom, 14 to 25 m depth, 18 May 1973, 2 September 1973, and 21 July 1976.

Description

Counts and proportional measurements are shown in Table 1. Dorsal fin-rays VI-I, 10; anal fin-rays I, 9; pectoral fin-rays 17 to 19; vertebrae 10+16=26; gill-rakers on lower limb of first arch 10 or 11; scales 80 to 101 in a longitudinal series,

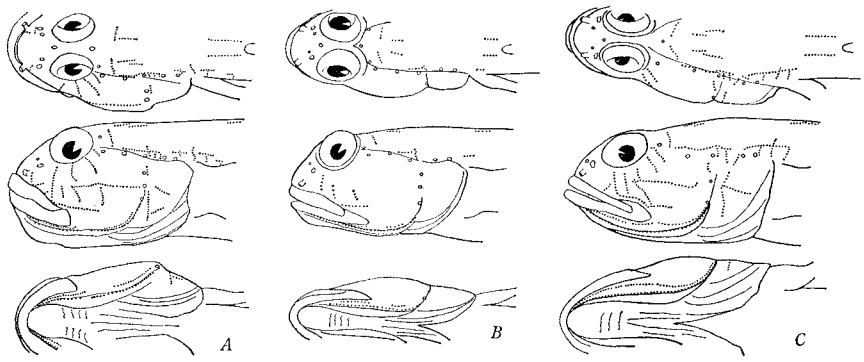

Fig. 3. Canal pores and sensory papillae. A- *Cryptocentrus singapurensis*, B- *Cryptocentrus flavus*, C- *Cryptocentrus filifer*.

23 to 29 in a transverse series.

Head cylindrical, body elongate, compressed. Interorbital space very narrow; snout obtuse, as long as eye diameter; anterior nostril with a short tube positioned close to lip, posterior nostril without rim positioned about halfway between the anterior margin of eye and anterior nostril. Mouth oblique, jaws subequal and upper jaw extending to a point below the posterior margin of eye or a little more. On upper jaw a band of pointed teeth in 3 or 4 series in front and in 2 series posteriorly, those of an outer series slightly enlarged. On lower jaw an inner band of small teeth, 2 or 3 series in front and one series posteriorly, a few inner teeth at the corner a little enlarged, and a single external series of about 9 larger teeth on each side extending to the middle of an inner band (Fig. 8–B). No teeth on vomer; the frontal part of vomer fairly noticeably protruding downward. Tongue rounded, glossohyal bone narrow fan-shaped. Gill-opening very wide, exceeding a point below the posterior margin of preopercle; isthmus narrow; no fleshy flap on the inner margin of shoulder girdle. No spine on preopercle. Canal pores and sensory papillae on head are shown in Fig. 3–C. Anterior oculoscapular canal with pores B′(6/6), C(5), D(6), E(0), F(6), G(6), H′(6); posterior oculoscapular canal with pores K′(6), L′(6); preopercular canal with pores M′(6), N(0), O′(6). Sensory papillae on head poorly defined. Along the side of body about 10 vertical series of papillae, each of which about one third of body height.

First dorsal fin higher than body, 1st to 5th spine filamentous, 2nd spine longest. Second dorsal fin as high as body. Anal fin as high as second dorsal fin, its origin at a point below 2nd soft ray of second dorsal fin. Caudal fin oblong or rounded, longer than head. Pectoral fin without silky free rays, rounded posteriorly, not reaching anus. Pelvic fins I, 5, both fins united, uniting membrane and frenum normally developed.

Scales all small cycloid, barely imbricating anteriorly. Head naked, the median part of nape, pectoral base, thorax and the anterior half of belly scaleless.

Colour of body faint brown above, pearl-like white below. Cheek and opercle scattered with small blue spots. Body with 6 diffuse dark brown transverse bands;

first on opercle, 2nd to 5th from first dorsal fin to caudal peduncle, 6th on the base of caudal fin. First dorsal fin dusky brown with an oblong black blotch at the base between first spine and second one. Second dorsal fin with 3 or 4 longitudinal series of orange spots. The basal half of anal fin white, the distal half dusky. Pectoral fin semitransparent. Pelvic fins whitish. The upper half of caudal fin with orange spots, the lower half dusky, the distal margin pale yellow.

II. *Mars* Jordan et Seale

(Jordan et Seale, 1906, p. 408)

Obtortiophagus Whitley, 1933, p. 90.

Body elongate, compressed, head roundish. Scales 55 to 130 in a longitudinal series, ctenoid posteriorly, cycloid anteriorly, or all cycloid. Head naked, the median part of nape naked or covered with small scales. Interorbital space very narrow. Snout obtuse, as long as or slightly longer than eye diameter. Mouth oblique, upper jaw reaching a point below the middle part of eye. Teeth on both jaws in several series, small, sharply pointed, and a few canine-like teeth in the middle of the inner or outer series. Tongue rounded. Gill-opening wide, extending to a point below the middle of preopercle or a little more. Sensory papillae on head fairly well developed, making reticulation on cheek. Dorsal fin-rays VI-I, 9 to 11; anal fin-rays I, 8 to 10. Pelvic fins united. Caudal fin rounded, as long as or slightly less than head.

a. Scales in a longitudinal series less than 100.
  b. Scales in a longitudinal series less than 65. .....1. *M. caeruleomaculatus*
  b′. Scales in a longitudinal series more than 65. .....2. *M. nigrocellatus*
a′. Scales in a longitudinal series more than 100. .....3. *M. albidorsus*

1. *Mars caeruleomaculatus* Herre

(Japanese name: Uruma-haze)

(Fig. 4, Pl. I–D)

Mars caeruleo-maculatus, Herre, 1933, p. 22.
Mars caeruleo-maculatus, Herre, 1934, p. 87.
Mars caeruleo-maculatus, Herre, 1937, p. 45.
Mars caeruleo-maculatus, Koumans, 1940, p. 147.
Mars caeruleo-maculatus, Koumans, 1953, p. 21.

Materials examined: One specimen from Hakebina Beach, Yoron Island, Nansei Islands, sand and coral bottom, 1.5 m depth, 13 November 1972. One specimen from Akasaki Reef, Yoron Island, Nansei Islands, sandy mud bottom, 1 m depth, 12 June 1973. Eight specimens from Kametoku Reef, Tokunoshima Island, Nansei Islands, sandy mud or mud bottom, 0.5 m to 2 m depth, 2 and

5 November 1973, 18 June 1973.

Description

Counts and proportional measurements are shown in Table 5. Dorsal fin-rays VI-I, 9 or 10; anal fin-rays I, 8 or 9; pectoral fin-rays 16 or 17; vertebrae 10+16=26 or 10+15=25; gill-rakers on lower limb of first arch 8 to 10; scales 58 to 65 in a longitudinal series, 18 to 21 in a transverse series.

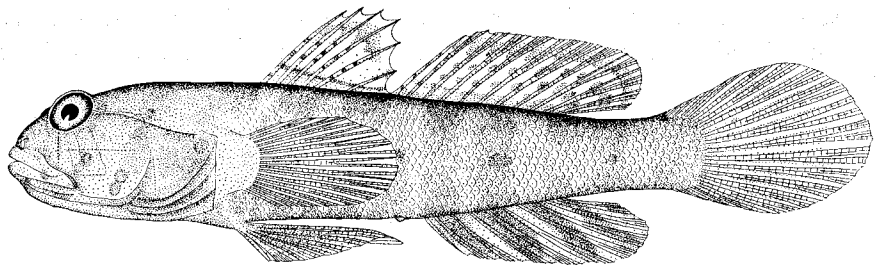

Fig. 4. *Mars caeruleomaculatus*, female, 36.2 mm in standard length.

Head roundish, body elongate, compressed, and convex anteriorly. Interorbital space very narrow, snout obtuse, as long as eye diameter; anterior nostril with a short tube positioned close to lip, posterior nostril without rim positioned about halfway between the anterior margin of eye and anterior nostril. Mouth oblique, jaws subequal and upper jaw reaching a point below the middle part of eye. On upper jaw a single external series of about 10 slender teeth, those in front larger, and an inner band of several irregularly arranged series of small teeth. On lower jaw an inner band of small teeth, several series in front and one or two series posteriorly, at the inner corner of which 1 to 3 canine-like teeth on each side, and an external series of about 6 pointed teeth in front, a few of which enlarged (Fig. 8–C). No teeth on vomer; the frontal part of vomer fairly noticeably protruding downward. Tongue rounded, glossohyal bone narrow fan-shaped. Gill-opening wide, extending to a point below the posterior part of opercle; isthmus moderate; no fleshy flap on the inner margin of shoulder girdle. No spine on preopercle. Canal pores and sensory papillae on head are shown in Fig. 6–A. Anterior oculoscapular canal with pores B′(7/7), C(7), D(7), E(7), F(7), G(7), H′(7); posterior oculoscapular canal with pores K′(7), L′(7); preopercular canal with pores M′(7), N(7), O′(7). Sensory papillae on head fairly noticeably developed.

First dorsal fin lower than body, 2nd or 3rd spine longest. Second dorsal fin as high as first one. Anal fin as high as second dorsal fin, rounded posteriorly, its origin at a point below 2nd soft ray of second dorsal fin. Caudal fin rounded, a little shorter than head. Pectoral fin without silky free rays, rounded posteriorly, nearly reaching a line vertically through anus. Pelvic fins I, 5, both fins united, uniting membrane and frenum normally developed.

Scales on the anterior half of body small and cycloid, becoming larger and ctenoid posteriorly. Head naked, the median part of nape and pectoral base scale-

less. Thorax scaly or not, belly scaly.

Colour of body dusky olive with 7 or 8 indistinct dark brown transverse bands. Reddish brown speckles on cheek and opercle. Four dark short bars along the middle of body. Many small blue spots on the posterior half of body. On the basal half of first dorsal fin thick vermilion spots, and on the distal half a dusky longitudinal band of the same colour. On the basal half of second dorsal fin pale dusky vermilion spots, and along the upper quarter a band of the same colour. Five dark brown bars, inclined backward and downward, across anal fin. Pectoral fin and caudal fin semi-transparent. Pelvic fins dusky with four pale vermilion spots arranged longitudinally.

2. *Mars nigrocellatus* n. sp.

(Japanese name: Kurohoshi-haze)

(Fig. 5, Pl. I–E)

Holotype: SMBL Type-293, adult female, 65.7 mm, Shiramizu, Kikai Island, Nansei Islands, sand, coral and rubble bottom, 5 m depth, 14 August 1975.

Paratypes: SMBL Type-294, adult male, same locality and data as holotype. SMBL Type-295, adult female, 59.0 mm, 11 June 1973, SMBL Type-296, adult female, 55.3 mm, 12 June 1973, SMBL Type-297, adult female, 62.5 mm, 29 October 1973, SMBL Type-298, adult male, 59.3 mm, 30 October 1973, Akasaki Reef, Yoron Island, Nansei Islands, sand, coral and rubble bottom, 1.5 m to 3 m depth.

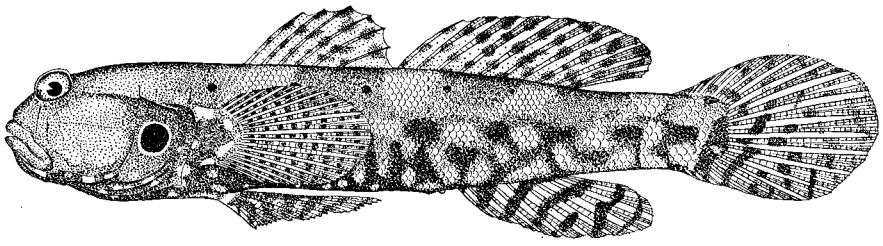

Fig. 5. *Mars nigrocellatus* n. sp., Holotype, SMBL Type-293, female, 65.7 mm in standard length.

Description

Counts and proportional measurements are shown in Table 3. Dorsal fin-rays VI-I, 9 to 11; anal fin-rays I, 8 or 9; pectoral fin-rays 16 or 17; vertebrae 10+16= 26; gill-rakers on lower limb of first arch 11 or 12; scales 69 to 78 in a longitudinal series, 20 to 25 in a transverse series.

Head roundish, somewhat bulbous; body elongate, subcylindrical and convex anteriorly, and compressed posteriorly. Interorbital space very narrow; snout obtuse, a little longer than eye diameter, anterior nostril with a short tube positioned close to lip, posterior nostril without rim positioned close to the anterior margin of

eye. Mouth oblique; jaws subequal and upper jaw reaching a point below the middle part of eye. On upper jaw 3 to 4 series of small teeth, 1 to 3 external teeth canine-like on each frontal side. On lower jaw an inner band of small teeth, several series in front and 2 series posteriorly, and an outer series of about 6 pointed teeth extending to the middle of an inner band on each side, its terminal tooth enlarged (Fig. 8–D). No teeth on vomer; the frontal part of vomer not noticeably protruding downard. Tongue rounded, glossohyal bone narrow fan-shaped. Gill-opening wide, extending to a point below the posterior end of preopercle; isthmus moderate; no fleshy flap on the inner margin of shoulder girdle. No spine on preopercle. Canal pores and sensory papillae on head are shown in Fig. 6–C. Anterior oculoscapular canal with pores B′(6/6), C(6), D(6), E(6), F(6), G(6), H′(6); posterior oculoscapular canal with pores K′(6), L′(6); preopercular canal with pores M′(6), N(6), O′(6). Sensory papillae on head fairly noticeably developed.

Table 3. Counts and proportional measurements of *Mars nigrocellatus*. Proportional measurements are expressed in thousandths of standard length.

	Holotype SMBL 293	Paratypes				
		SMBL 294	SMBL 295	SMBL 296	SMBL 297	SMBL 298
Sex	♀	♂	♀	♀	♂	♀
Standard length (mm)	65.7	50.2	59.0	62.5	59.3	55.3
Dorsal fin rays	VI-I, 9	VI-I, 10	VI-I, 10	VI-I, 10	VI-I, 10	VI-I, 10
Anal fin rays	I, 9	I, 9	I, 9	I, 8	I, 9	I, 8
Pectoral fin rays	17–16	16–16	17–17	16–16	16–17	17–17
Scales in longitudinal series	72	75	70	72	78	70
Scales in transverse series	21	24	22	22	25	20
Total length	1247	1285	1251	1230	1287	1284
Body height	193	211	205	197	196	208
Head length	275	283	283	274	287	295
Eye diameter	56	54	51	50	47	56
Interorbital width	17	18	17	18	19	16
Snout length	76	66	78	64	67	63
Caudal peduncle length	186	177	169	186	185	179
Caudal peduncle height	111	110	107	109	118	112
First dorsal fin length	131	139	153	139	153	130
Second dorsal fin length	161	165	156	146	182	179
Second dorsal fin base	257	277	280	264	285	269
Anal fin length	164	179	169	163	192	175
Anal fin base	154	185	168	163	191	172
Pectoral fin length	245	253	280	253	280	275
Pelvic fin length	204	209	220	197	219	208
Predorsal length	364	349	405	366	369	365
Presecond dorsal length	575	562	590	570	563	597
Prepelvic length	324	301	322	320	285	318
Preanal length	650	643	653	662	599	680

First dorsal fin lower than body height, 3rd spine longest. Second dorsal fin as high as first one. Anal fin as high as second dorsal fin, rounded posteriorly, its origin at a point below 3rd soft ray of second dorsal fin. Caudal fin rounded, slightly shorter than head. Pectoral fin without silky free rays, rounded posteriorly, not long enough to reach a line vertically through anus. Pelvic fins I, 5, both fins united, uniting membrane and frenum normally developed.

Scales on body all small cycloid. Head naked, the median part of nape with 3 to 11 small embedded scales. Pectoral base and belly scaly, thorax scaly or not.

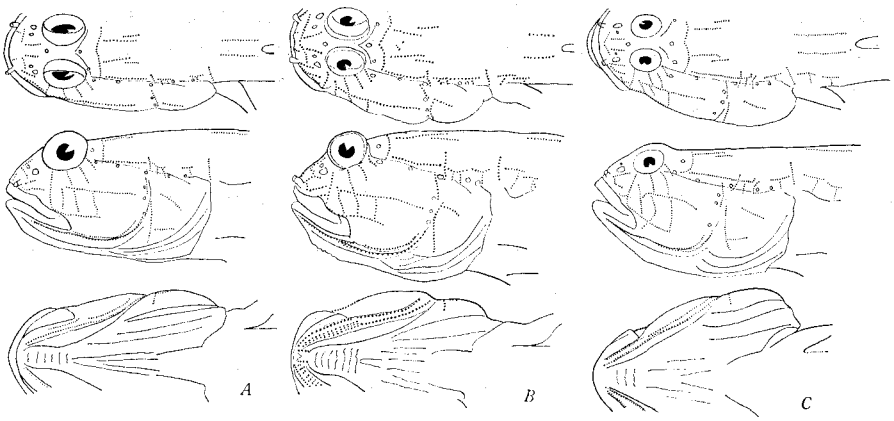

Fig. 6. Canal pores and sensory papillae. A- *Mars caeruleomaculatus*, B- *Mars koumansi*, C- *Mars nigrocellatus*.

Colour of body dusky brown with five white saddle-like speckles on dorsum, first of those on occipital region, 2nd on the origin of first dorsal fin, 3rd and 4th on the base of second dorsal fin and 5th on caudal peduncle. A large black ocellus bordered with white line on the center of opercle. Six or seven ill-defined blackish longitudinal short bars along the middle of body, and 4 to 6 small blackish spots along the upper quarter of body. The lower half of body scattered with many white dots. First and second dorsal fins and caudal fin with dark brown spots and short bars. Four dark brown bars, inclined forward and downward across anal fin. Pectoral fin semi-transparent with small spots along its rays. Pelvic fins with six transverse bands of dark brown.

3. *Mars albidorsus* n. sp.

(Japanese name: Shiro-obi-haze)

(Fig. 7, Pl. I–F)

Holotype: SMBL Type-299, adult female, 75.8 mm, Sonai, Iriomote Island, Nansei Islands, sand, coral and rubble bottom, 1 m depth, 17 February 1973.

Paratype: SMBL Type-300, adult female, 79.2 mm Akasaki Reef, Yoron Island,

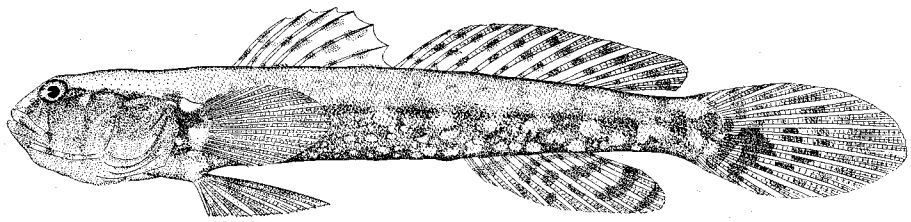

Fig. 7. *Mars albidorsus* n. sp., Holotype, SMBL Type-299, female, 75.8 mm in standard length.

Nansei Islands, sand, coral and rubble bottom, 1 m depth, 28 February 1973.

Description

Counts and proportional measurements are shown in Table 4. Dorsal fin-rays VI–I, 11; anal fin-rays I, 10; pectoral fin-rays 17; vertebrae 10+16=26; gill-rakers on lower limb of first arch 10 or 11; scales 113 to 130 in a longitudinal series, 32 to

Table 4. Counts and proportional measurements of *Mars albidorsus* and *M. koumansi*. Proportional measurements are expressed in thousandths of standard length.

	Mars albidorsus		*Mars koumansi*	
	Holotype SMBL 299	Paratype SMBL 300		
Sex	♀	♀	♂	♀
Standard length (mm)	75.8	79.2	51.5	45.5
Dorsal fin rays	VI-I, 11	VI-I, 11	VI-I, 10	VI-I, 10
Anal fin rays	I, 10	I, 10	I, 9	I, 9
Pectoral fin rays	17–17	17–17	17–16	16–15
Scales in longitudinal series	130	113	57	57
Scales in transverse series	35	32	19	19
Total length	1293	1263	1320	1275
Body height	160	170	225	232
Head length	248	246	303	303
Eye diameter	42	40	60	63
Interorbital width	13	19	19	22
Snout length	54	54	83	88
Caudal peduncle length	158	138	208	180
Caudal peduncle height	86	100	124	116
First dorsal fin length	139	126	373	240
Second dorsal fin length	158	157	210	178
Second dorsal fin base	325	331	278	264
Anal fin length	175	163	214	207
Anal fin base	181	194	235	220
Pectoral fin length	214	218	264	248
Pelvic fin length	185	172	225	240
Predorsal length	335	338	375	387
Presecond dorsal length	577	552	577	596
Prepelvic length	265	273	332	323
Preanal length	662	638	623	624

35 in a transverse series.

Head roundish, somewhat bulbous; body elongate, subcylindrical and convex anteriorly, and compressed posteriorly. Interorbital space very narrow; snout obtuse, a little longer than eye diameter; anterior nostril with a short tube positioned close to lip, posterior nostril without rim positioned close to the anterior margin of eye. Mouth oblique; jaws subequal and upper jaw reaching a point below the middle part of eye. On upper jaw 3 to 4 series of small teeth, 1 to 3 external teeth canine-like on each side. On lower jaw an inner band of small teeth, several series in front and 2 series posteriorly, and an outer series of about 6 pointed teeth extending to the middle of an inner band on each side, its terminal tooth enlarged. No teeth on vomer; the frontal part of vomer not noticeably protruding downward. Tongue rounded, glossohyal bone narrow fan-shaped. Gill-opening wide, nearly extending to a point below the middle of opercle; isthmus moderate; no fleshy flap on the inner margin of shoulder girdle. No spine on preopercle. Canal pores and sensory papillae on head are shown in Fig. 11–A. Anterior oculoscapular canal with pores B′(2/2), C(2), D(2), E(2), F(2), G(2), H′(2); posterior oculoscapular canal with pores K′(2), L′(2); preopercular canal with pores M′(2), N(2), O′(2). Sensory papillae on head fairly noticeably developed.

First dorsal fin lower than body height, 3rd or 4th spine longest. Second dorsal fin as high as first one. Anal fin as high as second dorsal fin, rounded posteriorly, its origin at a point below 4th soft ray of second dorsal fin. Caudal fin rounded, as long as head. Pectoral fin without silky free rays, rounded posteriorly, not long enough to reach a line vertically through anus. Pelvic fins I, 5, both fins united, uniting membrane and frenum normally developed.

Scales on body all small cycloid. Head naked, the median part of nape, pectoral base and thorax scaleless. Belly with minute scales.

Colour of body dark brown, with a broad white band on dorsum running from tip of mouth and snout to caudal peduncle along above the upper third part of body. About eight ill-defined dark longitudinal bars along the middle of body. The lower half of body with many white dots, those of the anterior part small and ill-defined. The upper edge and the lower half of pectoral base white. First and second dorsal fins and caudal fin semitransparent with dark brown spots and bars. Five or six dark brown bars, inclined forward and downward across anal fin. Pectoral fin semitransparent. The basal half of pelvic fins dark brown and the distal half colourless.

Remarks on species of genus Mars.

The genus *Mars* was established by Jordan and Seale (1906) for one specimen from Samoa to describe *M. strigilliceps*. Afterward, Herre (1933, 1937) described two other species of this genus, *M. caeruleomaculatus* and *M. haydeni* from Philippine, and Tomiyama (1955) reported *M. auropunctatus* from Japan. However, *M. haydeni* and *M. auropunctatus* must be included in other genera, and only *M. caeruleomaculatus* and *M. strigilliceps* are valid species of *Mars* hitherto known.

Table 5. Counts and proportional measurements of *Mars caeruleomaculatus*, *Vanderhorstia ornatissima* and *V. mertensi*. Proportional measurements are expressed in thousandths of standard length. Average is shown in a parenthesis and the number of specimens in a bracket.

	Mars caeruleomaculatus	*Vanderhorstia ornatissima*	*Vanderhorstia mertensi*
Number of specimens	11	7	6
Sex (♀+♂)	6+5	3+4	2+4
Standard length (mm)	30.8–40.7 (35.2)	34.6–46.1 (39.5)	32.2–48.5 (40.0)
Total length	1233–1298 (1287)	1321–1385 (1353)	1348–1484 (1420)
Body height	197– 224 (211)	150– 177 (169)	135– 151 (144)
Head length	289– 320 (307)	247– 282 (264)	233– 260 (249)
Eye diameter	64– 75 (68)	56– 69 (62)	60– 75 (69)
Interorbital width	8– 20 (10)	10– 17 (13)	9– 18 (14)
Snout length	65– 86 (78)	52– 61 (57)	40– 54 (46)
Caudal peduncle length	166– 206 (184)	152– 175 (158)	92– 115 (107)
Caudal peduncle height	105– 117 (109)	91– 100 (96)	74– 84 (79)
First dorsal fin length	149– 223 (183)	275– 413 (347)	242– 313 (276)
Second dorsal fin length	143– 215 (179)	144– 187 (164)	135– 165 (151)
Second dorsal fin base	249– 274 (257)	311– 338 (329)	354– 421 (382)
Anal fin length	174– 227 (206)	144– 174 (163)	125– 166 (148)
Anal fin base	188– 211 (198)	282– 325 (302)	345– 377 (359)
Pectoral fin length	244– 285 (268)	291– 347 (306)	230– 292 (257)
Pelvic fin length	214– 261 (238)	188– 233 (214)	185– 237 (214)
Predorsal length	351– 399 (376)	289– 315 (304)	282– 326 (298)
Presecond dorsal length	543– 592 (574)	484– 521 (507)	473– 519 (494)
Prepelvic length	317– 363 (336)	315– 360 (332)	289– 305 (297)
Preanal length	594– 655 (627)	532– 574 (559)	513– 549 (530)
Dorsal fin rays	VI-I, 9[1], 10[10]	VI-I, 12[1], 13[6]	VI-I, 15[1], 16[5]
Anal fin rays	I, 8[1], 9[10]	I, 13[7]	I, 16[2], 17[4]
Pectoral fin rays	16[15], 17[6]	18[8], 19[5]	16[1], 17[8], 18[2]
Scales in longitudinal series	58– 65 (60)	47– 55 (51)	62– 71 (65)
Scales in transverse series	18– 21 (20)	12– 16 (14)	15– 18 (16)

The genus *Obtortiophagus* was established for the sole species *O. koumansi* Whitley (1933) from Australia, which was supposed to be related to *Mars*. I lately collected two specimens of this species from Anae, Guam Island and made the comparison with the species of *Mars* in hand. Both genera have convex body, fairly developed sensory paipllae on head, 9 to 11 second dorsal soft rays and 8 to 10 anal soft rays. The resembrance between *O. koumansi* and *M. caeruleomaculatus* are especially striking (Table 4 and 5, Fig. 6–A and B). In addition to the meristic and proportional characters, colour pattern of both species closely resembles each other in detail. They can be barely distinguished by the differences of scales of the median part of nape (present in *O. koumansi*; absent in *M. caeruleomaculatus*) and the adult size (more than 50 mm in standard length in the former; about 40 mm in the latter). There seem to be no substantial differences between *Mars* and *Obtortiophagus* to separate them at generic

level. *Obtortiophagus* should rightly be united with *Mars* and should be treated as the synonym of the latter, which has been also suggested by Dr. D. Hoese (personal communication).

M. albidorsus can be easily distinguished from any other species of this genus by more elongated body, greater number of second dorsal soft rays (11; 9 or 10) and anal soft rays (10; 8 or 9), and more longitudinal scales (more than 100; less than 80). Moreover, a broad white longitudinal band running over the dorsal side is characteristic to this species. *M. nigrocellatus* is closely similar to *M. caeruleomaculatus*, *M. strigilliceps* and *M. koumansi*, but can be distinguished from them by having lower first dorsal fin, shorter anal fin base, smaller pelvic fins, and a black large ocellus bordered with white line on the center of opercle.

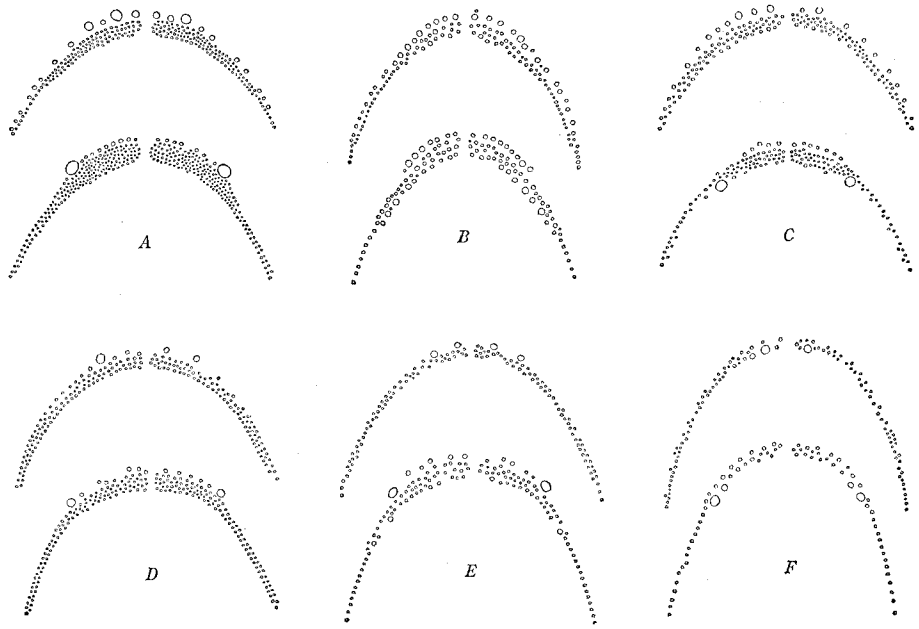

Fig. 8. Diagrammatic teeth arrangement in upper jaw (upper) and lower jaw (lower). A- *Cryptocentrus singapurensis*, B- *Cryptocentrus filifer*, C- *Mars caeruleomaculatus*, D- *Mars nigrocellatus*, E- *Vanderhorstia ornatissima*, F- *Vanderhorstia mertensi*.

III. *Vanderhorstia* J.L.B. Smith

(J.L.B. Smith, 1949, p. 103)

Body very elongate, slender and compressed, head subcylindrical. Scales 47 to 71 in a longitudinal series, ctenoid posteriorly, cycloid anteriorly. Head and the median part of nape naked. Interorbital space very narrow. Snout obtuse or slightly pointed, shorter than eye diameter. Mouth oblique, upper jaw reaching a point below eye. Teeth on both jaws in two or several series, 1 to 3 teeth in the

outer or inner series enlarged on each side. Tongue rounded. Gill-opening very wide, extending to a point below the posterior end of eye. Sensory papillae on head poorly defined. Dorsal fin-rays VI-I, 12 to 16; anal fin-rays I, 12 to 17. Pelvic fins united. Caudal fin lanceolate, longer than head.

a. Caudal fin asymmetrically lanceolate. .....1. *V. ornatissima*
a′. Caudal fin symmetrically lanceolate.
  b. Second dorsal rays 15 or 16. .....2. *V. mertensi*
  b′. Second dorsal soft rays 12. .....3. *V. lanceolata*

1. *Vanderhorstia ornatissima* J.L.B. Smith

(Japanese name: Yatsushi-haze)

(Fig. 9, Pl. I-G)

Vanderhorstia ornatissima J.L.B. Smith, 1959, p. 192. pl. 10–C.
Vanderhorstia ornatissima Masuda, Araga et Yoshino, 1975, p. 277, pl. 92–D.
Vanderhorstia ornatissima Polunin et Lubbock, 1977, p. 68, fig. 2.

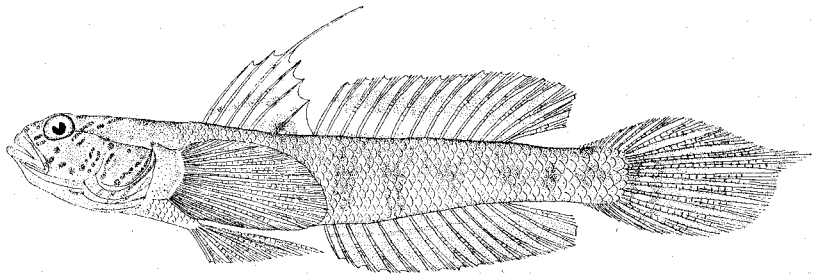

Fig. 9. *Vanderhorstia ornatissima*, female, 38.6 mm in standard length.

Material examined: Seven specimens from Akasaki Reef, Yoron Island, Nansei Islands, sand or sandy mud bottom, 0.5 m to 1.5 m depth, 11 November 1972, 26 February 1973 and 2 May 1973.

Description

Counts and proportional measurements are shown in Table 5. Dorsal fin-rays VI-I, 12 or 13; anal fin-rays I, 13; pectoral fin-rays 18 or 19; vertebrae 10+16=26; gill-rakers on lower limb of first arch 7 or 8; scales 47 to 65 in a longitudinal series, 12 to 16 in a transverse series.

Head subcylindrical, body elongate, compressed. Interorbital space very narrow; snout obtuse, as long as or slightly shorter than eye diameter; anterior nostril with a short tube positioned about halfway between the posterior margin of lip and posterior nostril, posterior nostril without rim positioned about halfway between anterior nostril and the anterior margin of eye. Mouth oblique, jaws subequal and upper jaw reaching a point below the anterior part of eye. On upper jaw a band of 2 or 3 series of fine teeth, one or two of which in outer front canine-like. On lower jaw an inner band of small teeth, 2 or 3 series in front and one series posteriorly,

and an outer series of about 6 pointed teeth extending to the middle of an inner band on each side, its one or two terminal teeth canine-like (Fig. 8-E). No teeth on vomer; the frontal part of vomer not noticeably protruding downward. Tongue rounded, glossohyal bone narrow fan-shaped. Gill-opening wide, extending to a point below the posterior part of preopercle; isthmus narrow; no fleshy flap on the inner margin of shoulder girdle. No spine on opercle. Canal pores and sensory papillae on head are shown in Fig. 11-B. Anterior oculoscapular canal with pores B′(7/7), C(7), D(7), E(7), F(7), G(7), H′(7); posterior oculoscapular canal with pores K′(7), L′(7); preopercular canal with pores M′(7), N(7), O′(7). Sensory papillae on head very poorly defined.

First dorsal fin lower than body 3rd spine filamentous. Second dorsal fin as high as first one. Anal fin as high as second dorsal fin, its origin at a point below first soft ray of second dorsal fin. Caudal fin asymmetrically lanceolate, the ray a little upper from the center longest, slightly longer than head. Pectoral fin without silky free rays, rounded posteriorly, reaching a line vertically through the origin of second dorsal fin. Pelvic fins I, 5, both fins united, uniting membrane and frenum normally developed.

Scales on the anterior half of body small and cycloid, becoming larger and ctenoid posteriorly. Head naked, the median part of nape scaleless. Thorax and belly scaly, pectoral base scaly or not.

Colour of body pale yellow, with several short bars of dark brown along the middle of body and indefinite blotches of the same colour along the upper quarter of body. Several series of orange vermiculate streaks and blotches bordered with light blue inclined forward and downward on head, and reddish orange spots bordered with light blue on the lower half of body. Dorsal fin transparent or pale yellow with two stripes on the basal part, the upper one orange and the lower one light blue. Second dorsal fin pale yellow, its basal part and distal edge paler blue. Anal fin and pectoral fin semitransparent. Caudal fin with two or three red streaks along the rays at the upper quarter and the lower quarter respectively. Pelvic fins yellowish, with two orange short bars near the middle of uniting membrane and a light blue semicircular streak around them.

2. *Vanderhorstia mertensi* Klausewitz

(Japanese name: Kusa-haze)

(Fig. 10, Pl. I-H)

Vanderhorstia mertensi Klausewitz, 1976b, p. 210, figs. 5–7.
Vanderhorstia sp., Masuda, Araga et Yoshino, 1975, p. 278, pl. 92–F.

Material examined: Five specimens from Hatake-zima Island, Shirahama, Wakayama Prefecture, mud bottom, 5 m to 10 m depth, 16 May 1973, 12 and 27 September 1973, 13 May 1974. One specimen from Ohmura Beach, Chichizima Island, Ogasawara Islands, sandy mud bottom, 10 m depth, 16 April 1974.

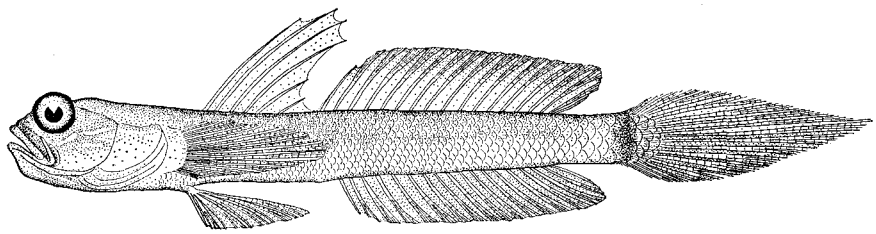

Fig. 10. *Vanderhorstia mertensi*, female, 40.0 mm in standard length.

Description

Counts and proportional measurements are shown in Table 5. Dorsal fin-rays VI-I, 15 or 16; anal fin-rays I, 16 or 17; pectoral fin-rays 16 to 18; vertebrae 10+16= 26; gill-rakers on lower limb of first arch 12 to 14; scales 62 to 71 in a longitudinal series, 15 to 18 in a transverse series.

Head subcylindrical, body very elongate, compressed. Interoribital space very narrow, snout shorter than eye diameter; anterior nostril with a short tube positioned about halfway between the posterior margin of lip and posterior nostril, posterior nostril without rim positioned close to the anterior margin of eye. Mouth oblique, jaws subequal and upper jaw reaching a point below the posterior part of eye. On upper jaw two series of fine teeth, and one or two frontal canine-like teeth in the outer or inner series on each side. On lower jaw a band of fine teeth, two or three series in front and a single series posteriorly, inside of which one or two canine-like teeth at the corner (Fig. 8-F). No teeth on vomer; the frontal part of vomer protruding downward. Tongue rounded, glossohyal bone narrow fan-shaped. Gill-opening very wide, nearly extending to a point below the posterior end of eye; isthmus narrow; no fleshy flap on the inner margin of shoulder girdle No spine on opercle. Canal pores and sensory papillae on head are shown in Fig. 11-C. Anterior oculoscapular canal with pores B′(6/6), C(5), D(6), E(6), F(6), G(6), H′(6); posterior oculoscapular canal with pores K′(6), L′(6); preopercular canal with pores M′(6),

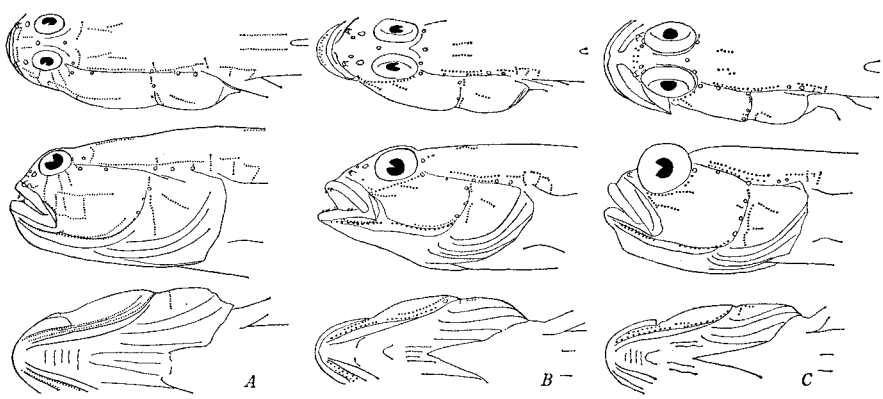

Fig. 11. Canal pores and sensory papillae. A-*Mars albidorsus*, B- *Vanderhorstia ornatissima*, C- *Vanderhorstia mertensi*.

N(6), O'(6). Sensory papillae on head very poorly defined.

First dorsal fin higher than body, 2nd or 3rd spine longest. Second dorsal fin lower than body. Anal fin as high as second dorsal fin, its origin at a point below between 1st and 2nd soft rays of second dorsal fin. Caudal fin symmetrically lanceolate, longer than head. Pectoral fin without silky free rays, rounded posteriorly, nearly reaching a line vertically through the origin of second dorsal fin. Pelvic fins I, 5, both fins united, uniting membrane and frenum normally developed.

Scales on the anterior half of body small and cycloid, becoming larger and ctenoid posteriorly. Head naked, the median part of nape and pectoral base scaleless. Thorax and belly scaly.

Colour of body creamy white with a tinge of light blue. Dorsal side of body more or less pale brown. Head and pectoral base with indistinct yellow short bars, and bluish around them. A dusky vertical bar on caudal base. Thorax and belly whitish. First dorsal fin with many small spots of light blue. Second dorsal fin semitransparent, its basal part and distal edge light blue. Anal fin pale, its basal part creamy and distal edge light blue. Pectoral fin colourless, pelvic fins scattered with small yellow spots. Caudal fin pale yellow, its distal edge light blue.

3. *Vanderhorstia lanceolata* n. sp.

(Japanese name: Yaziri-haze)

(Fig. 12, Pl. I-I)

Vanderhorstia sp., Masuda, Araga et Yoshino, 1975, p. 278, p. 92-E.

Holotype: SMLB Type-301, adult female, 40.2 mm, Hatake-zima Island, Shirahama, Wakayama Prefecture, mud bottom, 15 m depth, 27 September 1973.

Paratypes: SMBL Type-302, adult female, 34.6 mm, same locality as holotype, 2 September 1973. SMBL Type-303, adult male, 41.6 mm, same locality and date as holotype.

Description

Counts and proportional measurements are shown in Table 6. Dorsal fin-rays VI-I, 12; anal fin-rays I, 12; pectoral fin-rays 16 to 18; vertebrae 10+16=26; gill-

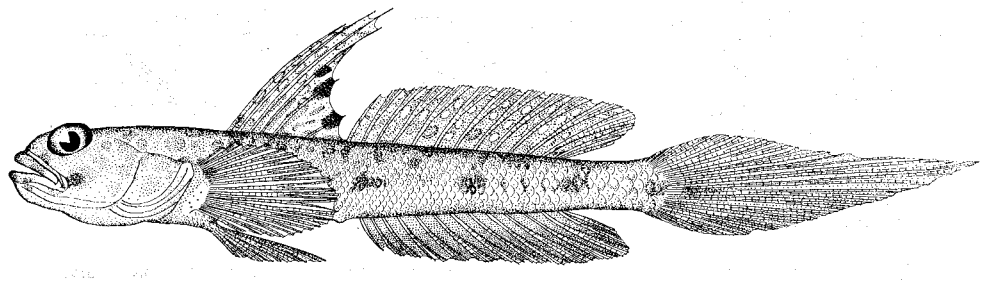

Fig. 12. *Vanderhorstia lanceolata* n. sp., Paratype, SMBL Type-303, male, 41.6 mm in standard length.

rakers on lower limb of first arch 6 or 7; scales 54 to 58 in a longitudinal series, 15 or 16 in a transverse series.

Head subcylindrical, body elongate, compressed. Interorbital space very narrow, snout shorter than eye diameter; anterior nostril with a short tube positioned about halfway between the posterior margin of lip and posterior nostril, posterior nostril without rim positioned close to the anterior margin of eye. Mouth oblique, jaws subequal and upper jaw reaching a point below the middle part of eye. On upper jaw a band of two or three irregularly arranged series of fine teeth, the frontal outside of which one or two canine-like teeth on each side. On lower jaw a band of fine teeth, three or four series in front and a single series posteriorly, and one to three canine-like recurved teeth at the outer corner. No teeth on vomer; the frontal part of vomer not protruding downward. Tongue rounded, glossohyal bone narrow fan-shaped. Gill-opening very wide, a little exceeding a point below the posterior end of preoper-

Table 6. Counts and proportional measurements of *Vanderhorstia lanceolata*. Proportional measurements are expressed in thousandths of standard length.

	Holotype SMBL 301	Paratypes SMBL 302	Paratypes SMBL 303
Sex	♀	♂	♀
Standard length (mm)	40.2	41.6	34.6
Dorsal fin rays	VI-I, 12	VI-I, 12	VI-I, 12
Anal fin rays	I, 12	I, 12	I, 12
Pectoral fin rays	17–17	17–18	16–16
Scales in longitudinal series	58	60	56
Scales in transverse series	15	16	15
Total length	1452	1510	143
Body height	164	146	153
Head length	279	276	266
Eye diameter	70	67	75
Interorbital width	5	5	3
Snout length	62	60	52
Caudal peduncle length	132	142	127
Caudal peduncle height	80	77	84
First dorsal fin length	204	264	199
Second dorsal fin length	139	156	133
Second dorsal fin base	311	337	335
Anal fin length	124	166	133
Anal fin base	271	313	286
Pectoral fin length	229	228	188
Pelvic fin length	174	195	173
Predorsal length	331	312	324
Presecond dorsal length	547	507	543
Prepelvic length	323	315	301
Preanal length	612	558	598

cle; isthmus narrow; no fleshy flap on the inner margin of shoulder girdle. No spine on opercle. Canal pores and sensory papillae on head are shown in Fig. 13-A. Anterior oculoscapular canal with pores B'(3/3), C(3), D(3), E(3), F(3), G(3), H' (3). Posterior oculoscapular canal and preopercular canal absent. Sensory papillae on head very poorly defined.

First dorsal fin higher than body, 2nd or 3rd spine longest. Second dorsal fin lower than body. Anal fin as high as second dorsal fin, its origin at a point below 2nd soft ray of second dorsal fin. Caudal fin symmetrically lanceolate, longer than head. Pectoral fin without silky free rays, rounded posteriorly, only reaching a line vertically through the posterior part of first dorsal fin. Pelvic fins I, 5, both fins united, uniting membrane and frenum normally developed.

Scales on the anterior half of body small and cycloid, becoming larger and ctenoid posteriorly. Head naked, the median part of nape and pectoral base scaleless. Thorax and belly scaly.

Colour of body paler light brown with five dark brown blotches along the middle of body, first below first dorsal fin and fifth on caudal base. Head and the upper half of body scattered with brown speckles. Ventral side of body whitish. Brown streaks and blotches along the rays of first dorsal fin, and a distinct blotch of dark brown on the distal edge of 5th and 6th spine respectively. Second dorsal fin with several larger spots of dark brown along the middle and many smaller ones of light brown all over the fin. Anal fin semitransparent with a longitudinal dark brown stripe along the middle. Pectoral fin colourless, pelvic fins brownish around uniting membrane. Caudal fin semitransparent with a longitudinal narrow stripe of dark brown along the median.

Remarks on species of genus Vanderhorstia

The genus *Vanderhorstia* comprises three species so far; *V. delagoae* (Barnard), *V. ornatissima* J.L.B. Smith from South Africa, and *V. mertensi* Klausewitz from the Red Sea. According to Klausewitz (1974b), these three species are easily distinguishable from one another by their colourlation, and *V. mertensi* is different from the other two species as having more soft rays of second dorsal and anal fins (16, 13; 17–18, 13). As for *V. delagoae* and *V. ornatissima,* the former has 55 scales and its longest first dorsal spine is 5th, while the latter has 65 scales and its longest first dorsal spine is 2nd, 3rd or 4th. *V. ornatissima* and *V. mertensi* caught from Japanese waters have the similar characters to those from South Africa and the Red Sea respectively, though their differences in some characters can not be neglected. *V. ornatissima* from Japan has less number of scales and pectoral fin rays than that from South Africa (47–55, 65; 18–19, 20); and *V. mertensi* from Japan exceeds that from the Red Sea in number of scales (62–71, 60–62). These geographical differences can be regarded as the intraspecific variations. Although *V. ornatissima* has been so far known only from South Africa and Japan, and *V. mertensi* from the Red Sea and Japan, their distribution may cover all over the shallow waters of the Indo-Pacific regions.

The newly described species *V. lanceolata* is clearly distinguished from the other species of this genus by the distinct five dark brown blotches along the middle of

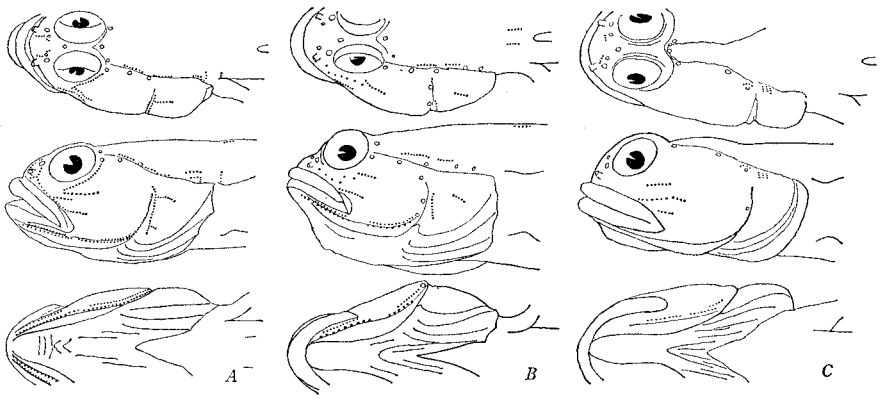

Fig. 13. Canal pores and sensory papillae. A- *Vanderhorstia lanceolata*, B- *Ctenogobiops crocineus*, C- *Tomiyamichthys oni*.

body. Moreover, shorter length of pectoral fin and lack of posterior oculoscapular canal and preopercular canal are characteristic to this species.

IV. *Ctenogobiops* J.L.B. Smith

(J.L.B. Smith, 1959, p. 191)

Body elongate, compressed, head slightly compressed. Scales 55 to 61 in a lingitudinal series, ctenoid posteriorly, cycloid anteriorly. Head and the median part of nape naked. Interorbital space very narrow. Snout slightly pointed, shorter than eye diameter. Mouth oblique, upper jaw reaching a point below the middle or posterior part of eye. Teeth on upper jaw in several series, 1 to 4 canine-like teeth at the corner of the inner series. Tongue rounded. Gill-opening very wide, exceeding a point below the posterior margin of preopercle. Sensory papillae on head poorly defined. Dorsal fin-rays VI-I, 11 or 12; anal fin-rays I, 11. Pelvic fins united. Caudal fin rounded, as long as head.

1. *Ctenogobiops crocineus* J.L.B. Smith

(Japanese name: Shinobi-haze)

(Pl. II-A)

Ctenogobiops crocineus J.L.B. Smith, 1959, p. 191, pl. 11-K.
Ctenogobiops maculosus Klausewitz, 1960, p. 156, fig. 7.
Ctenogobiops crocineus Polunin et Lubbock, 1977, p. 70, fig. 3.

Material examined: One specimen from Shinsato, Okinawa Island, Nansei Islands, sand, coral and rubble bottom, 2 m depth, 4 February 1973. One specimen from Shioya Bay, Okinawa Island, Nansei Islands, sand bottom, 2 m depth, 8 February 1973. Two specimens from reef near Todoroki River, Ishigaki Island,

Nansei Islands, sand, coral and rubble bottom, 1 m depth, 13 February 1973. One specimen from Chinasaki, Okinawa Island, Nansei Islands, sand bottom, 1.5 m depth, 19 October 1974. Two specimens from Rison, Palau Islands, coral sand bottom, 1.5 m depth, 2 November 1976.

Description

Counts and proportional measurements are shown in Table 7. Dorsal fin-rays VI-I, 11; anal fin-rays I, 11; pectoral fin-rays 19; vertebrae 10+16=26; gill-rakers on lower limb of first arch 10 or 11; scales 56 to 61 in a longitudinal series, 17 to 20 in a transverse series.

Head slightly compressed, body elongate, compressed. Interorbital space very narrow; snout slightly pointed, shorter than eye diameter; anterior nostril with a short tube positioned about halfway between lip and the anterior margin of eye, posterior nostril without rim positioned close to the anterior margin of eye. Mouth

Table 7. Counts and proportional measurements of *Ctenogobiops crocineus* and *Tomiyamichthys oni*. Proportional measurements are expressed in thousandths of standard length. Average is shown in a parenthesis and the number of specimens in a bracket.

	Ctenogobiops crocineus	*Tomiyamichthys oni*
Number of specimens	7	9
Sex (♀+♂)	2+5	8+1
Standard length (mm)	27.4–44.7 (36.6)	30.7–71.8 (61.1)
Total length	1268–1332 (1297)	1230–1280 (1256)
Body height	193– 215 (204)	135– 176 (150)
Head length	291– 329 (311)	262– 295 (278)
Eye diameter	73– 88 (80)	54– 68 (61)
Interorbital width	9– 21 (14)	7– 21 (20)
Snout length	63– 78 (71)	44– 61 (52)
Caudal peduncle length	178– 197 (186)	116– 138 (127)
Caudal peduncle height	97– 114 (108)	75– 87 (83)
First dorsal fin length	182– 306 (236)	176– 211 (196)
Second dorsal fin length	162– 212 (181)	137– 171 (154)
Second dorsal fin base	255– 271 (264)	300– 343 (323)
Anal fin length	153– 182 (172)	123– 155 (145)
Anal fin base	215– 251 (229)	244– 283 (262)
Pectoral fin length	298– 343 (327)	207– 266 (232)
Pelvic fin length	201– 219 (209)	173– 254 (195)
Predorsal length	321– 376 (352)	327– 367 (343)
Presecond dorsal length	535– 579 (550)	543– 578 (558)
Prepelvic length	333– 379 (362)	284– 336 (316)
Preanal length	551– 602 (589)	599– 638 (617)
Dorsal fin rays	VI-I, 11[7]	VI-I, 11[9]
Anal fin rays	I, 11[7]	I, 10[1], 11[8]
Pectoral fin rays	19[14]	17[15], 18[3], 19[1]
Scales in longitudinal series	56– 61 (59)	74– 91 (80)
Scales in transverse series	17– 20 (28)	21– 22 (21)

slightly oblique, jaws subequal and upper jaw reaching a point below the middle of eye. On upper jaw a single external series of about 17 inwardly recurved teeth, those in front canine-like, and an inner band of small teeth, several series in front and two series posteriorly. On lower jaw an external series of inwardly recurved teeth, those in front a little enlarged, and an inner band of several irregularly arranged series of small teeth in front, followed by one to three canine-like teeth at the inner corner (Fig. 19-A). No teeth on vomer; the frontal part of vomer protruding downward fairly well. Tongue rounded, glossohyal bone narrow fan-shaped. Gill-opening very wide, exceeding a point below the posterior margin of preopercle; isthmus narrow; no fleshy flap on the inner margin of shoulder girdle. No spine on preopercle. Canal pores and sensory papillae on head are shown in Fig. 13-B. Anterior oculoscapular canal with pores B′(7/7), C(7), D(7), E(7), F(7), G(7), H′(7); posterior oculoscapular canal with pores K′(7), L′(7); preopercular canal with pores M′(7), N(7), O′(7). Sensory papillae on head very poorly defined.

First dorsal fin lower than body, 1st or 2nd spine longest. Second dorsal fin lower than body. Anal fin as high as second dorsal fin, its origin at a point below 1st or 2nd soft ray of second dorsal fin. Caudal fin rounded posteriorly, as long as head. Pectoral fin oblong without silky free rays, exceeding a line vertically through the origin of anal fin. Pelvic fins I, 5, both fins united, uniting membrane and frenum normally developed.

Scales on belly and the anterior part of body up to the middle of first dorsal fin base cycloid, and becoming larger and ctenoid on the posterior part of body. Head naked, the median part of nape, pectoral base and thorax scaleless.

Colour of body creamy white with six brown horizontal short bars along the middle of body from below first dorsal fin to the posterior end of caudal peduncle, many brown speckles on the upper half of body, and about seven small spots of golden brown along the lower quarter of body. Head scattered with brown spots, its lower part white. A distinct white speckle on the middle of pectoral base. First and second dorsal fins transparent with the creamy basal part and a longitudinal stripe of gold colour above it. The basal half of anal fin creamy, and the distal half dusky. Pelvic fins grey. Pectoral fins and caudal fin colourless.

V. *Tomiyamichthys* J.L.B. Smith

(J.L.B. Smith, 1956, p. 553)

Body elongate, slightly compressed, head cylindrical. Cheeks plump, their dorsal margins coming close each other at occipital region (Fig. 13-C). Scales 70 to 95 in a longitudinal series, all cycloid barely imbricating and, more or less, embedded. Head and the median part of nape naked, body completely scaly or scaleless along the dorsal and ventral margins. Interorbital space very narrow. Snout obtuse, slightly shorter than eye diameter. Mouth horizontal, upper jaw extending beyond eye. Teeth on both jaws in several series, the outer enlarged, and several front

teeth in the inner series on upper jaw enlarged. Tongue rounded. Gill-opening moderate, barely exceeding the lower end of pectoral base. Sensory papillae on head very poorly defined. Dorsal fin-rays VI-I, 11; anal fin-rays I, 10 or 11. Pelvic fins united. Caudal fin rounded, as long as or slightly shorter than head.

1. *Tomiyamichthys oni* (Tomiyama)

(Japanese name: Oni-haze)

(Pl. II-B)

Cryptocentrus oni Tomiyama, 1936, p.82, fig. 32.
Cryptocentrus oni Masuda, Araga et Yoshino, 1975, p. 277, pl. 92-A.

Material examined: Three specimens from Shirahama, Wakayama Prefecture, sand, pebbles and coral rubble bottom, 4 m to 10 m depth, 6 May 1973, 30 May 1974, 18 May 1976. Six specimens from Ohmura Beach, Chichi-zima Island, Ogasawara Islands, sandy mud bottom, 4 m to 8 m depth, 10, 16 and 18 April 1974.

Description

Counts and proportional measurements are shown in Table 7. Dorsal fin-rays VI-I, 11; anal fin-rays I, 10 or 11; pectoral fin-rays 17 to 19; vertebrae 10+16=26; gill-rakers on first arch 1+2 or 3 (Fig. 14); scales 74 to 91 in a longitudinal series, 21 or 22 in a transverse series.

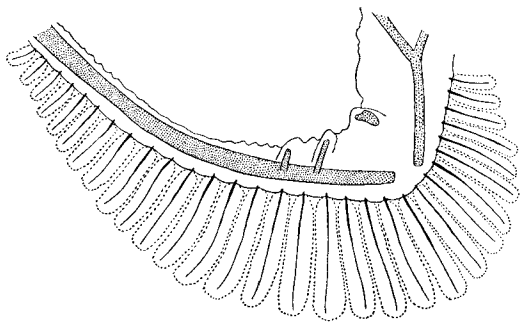

Fig. 14. Outer face of first gill arch in *Tomiyamichthys oni*. Stipple indicates the parts stained by alizarine-red.

Head cylindrical; cheeks plump, their dorsal margins coming close each other at occipital region and making a pair of grooves running from interorbit to the upper end of opercle (Fig. 13-C). Body elongate, compressed slightly. Interorbital space very narrow; snout obtuse, slightly shorter than eye diameter; anterior nostril with a short tube positioned close to lip, posterior nostril without rim positioned about halfway between the anterior margin of eye and anterior nostril. Mouth horizontal, jaws subequal and upper jaw exceeding a point below the posterior margin of eye. On upper jaw a single external series of about 15 larger slender teeth on each side, and an inner band of small teeth, two or three series in front and one series posteri-

orly, several of which in the inner series enlarged in front. On lower jaw a band of several irregularly arranged series of small teeth, several external teeth slightly enlarged in front (Fig. 19-B). Each lip with a papillate fringe in front of teeth. No teeth on vomer; the frontal part of vomer not protruding downward. Tongue rounded, glossohyal bone narrow fan-shaped. Gill-opening moderate, barely exceeding the lower end of pectoral base; isthmus moderate; no fleshy flap on the inner margin of shoulder girdle. No spine on preopercle. Canal pores and sensory papillae on head are shown in Fig. 13-C. Anterior oculoscapular canal with pores B′(7), C(7), D(7), E(7), F(7), G(2), H′(7). Posterior oculoscapular canal absent. Preopercular canal with pores M′(7), N(0), O′(6). Sensory papillae on head very poorly defined. On the side of body about 15 vertical series of papillae, each of which about one third of body height.

First dorsal fin slightly higher than body, 2nd or 3rd spine longest. Second dorsal fin lower than body. Anal fin as high as second dorsal fin, its origin at a point below 2nd soft ray of second dorsal fin. Caudal fin rounded, as long as or slightly shorter than head. Pectoral fin without silky free rays, rounded posteriorly, only reaching a line vertically through the posterior part of first dorsal fin. Pelvic fins I, 5, both fins united, uniting membrane and frenum normally developed.

Scales of body all minute cycloid, barely imbricating and, more or less, embedded.

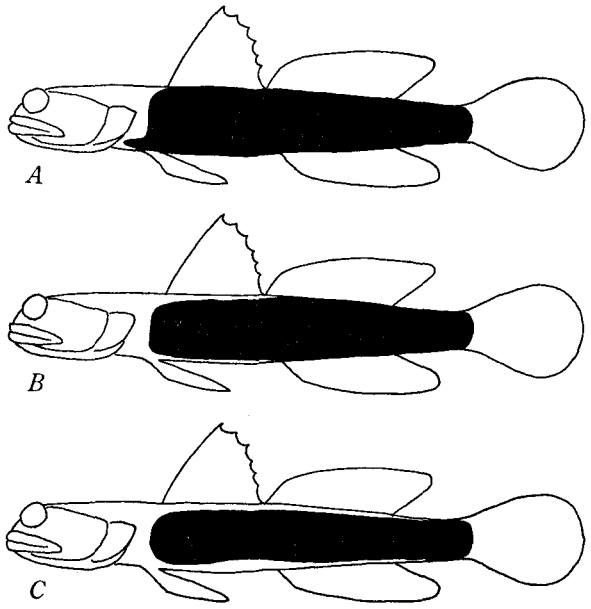

Fig. 15. Variations in covering of scales in *Tomiyamichthys oni*. Black area shows covering of scales. A- female, 64.2 mm in standard length, from Shirahama, Wakayama Prefecture, B- female, 58.0 mm in standard length, from Shirahama, Wakayama Prefecture, C- female, 71.8 mm in standard length, from Chichi-zima Island, Ogasawara Islands.

Head naked, the median part of nape, pectoral base and thorax scaleless. Variations are seen in the presence of scales on dorsum and belly; in some specimens the median part of dorsum and belly completely scaly, but in others scaleless (Fig. 15).

Colour of body creamy with irregularly arranged dark brown speckles on the middle and upper parts of body, and 5 to 7 larger ones along the middle of body. Snout, both jaws, the upper half of cheek, occipital region and nape brownish. A dark brown streak running from below eye to behind jaws, and a streak of black or dark brown from chin to the lower part of opercle via branchiostegal membrane. The median part of thorax brown. First dorsal fin with many brown spots, and a black spot at the tip of 3rd spine. Second dorsal fin with many brown spots. Anal fin whitish olive with blackish bars along the distal edge. Pectoral fins semitransparent with small yellowish spots on membrane. Membrane of pelvic fins dusky blue, soft rays whitish. Caudal fin semitransparent with a few brown streaks along the upper and lower quarters respectively.

Remarks

Tomiyama (1936) described this species as a member of the genus *Cryptocentrus*. Afterward, J.L.B. Smith (1956) proposed new genus *Tomiyamichthys* for this species, as having minute scales, less compressed body, shorter caudal fin and transverse series of papillae along the middle side of body. Besides those characters, this species can be differentiated from *Cryptocentrus* in having restricted gill-opening barely exceeding the lower end of pectoral base and plump cheeks coming close each other at occipital region. It seems adequate to separate this species from *Cryptocentrus*. *Tomiyamichthys* has close affinities with *Flabelligobius* J.L.B. Smith (1956) and *Eilatia* Klausewitz (1974b).

VI. *Amblyeleotris* Bleeker

(Bleeker, 1874, p. 374)

Pteroculiops Fowler, 1938, p. 133.
Zebreleotris Herre, 1953a, p. 191.
Cryptocentrops J.L.B. Smith, 1958, p. 152.

Body elongate, compressed, head roundish. Scales 60 to 95 in a longitudinal series, ctenoid posteriorly, cycloid anteriorly. Head naked, the median part of nape covered with small scales or scaleless. Interorbital space very narrow. Snout obtuse, as long as eye diameter. Mouth oblique, upper jaw extending to a point below the middle or posterior part of eye. Teeth on both jaws in several series, a single external series of about 15 larger teeth on upper jaw, and 1 to 4 canine-like teeth at the inner corner on lower jaw. Tongue rounded. Gill-opening very wide, exceeding a point below the posterior margin of preopercle. Sensory papillae on head poorly defined. Dorsal fin-rays VI-I, 11 to 14; anal fin-rays I, 12 to 14. Uniting membrane of pelvic fins not fully developed or rudimentary, 4th soft ray longest; pelvic frenum rudimentary or absent. Caudal fin oblong or rounded, about as long

as or longer than head.

a. Five transverse band on body.
  b. Outlines of transverse bands not smooth, and some speckles irregularly scattered on interspaces of bands. .....1. *A. maculata*
  b′. Outlines of transverse bands nearly straight, and interspace of bands clear.
    c. Band broader than interspace. .....2. *A. fasciata*
    c′. Band narrower than or as broad as interspace.
      d. Rudimentary pelvic frenum present. .....3. *A. japonica*
      d′. Pelvic frenum absent.
        e. Second dorsal soft rays 11 or 12 .....4. *A. steinitzi*
        e′. Second dorsal soft rays 13 or 14 .....5. *A. ogasawarensis*
a′. Not five transverse bands on body .....6. *A. guttata*

1. *Amblyeleotris maculata* Yanagisawa

(Japanese name: Dandara-datehaze)

Amblyeleotris sp. Masuda, Araga et Yoshino, 1975, p. 274, pl. 90–J.
Amblyeleotris maculata Yanagisawa, 1976, p. 147, fig. 2.

Dorsal fin-rays VI-I, 12, anal fin-rays I, 12, pectoral fin-rays 19 or 20; vertebrae 10+16=26; gill-rakers on lower limb of first arch 9; scales about 85 in a longitudinal series, 26 or 27 in a transverse series. For the further description see Yanagisawa (1976).

2. *Amblyeleotris fasciata* (Herre)

(Japanese name: Kubiaka-haze)

Zebreleotris fasciata Herre, 1953a, p. 191.
Zebreleotris fasciata Herre, 1953b, p. 357.
Amblyeleotris sp. Masuda, Araga et Yoshino, 1975, p. 274, pl. 90–K.
Amblyeloetris fasciata Yanagisawa, 1976, p. 150, fig. 3.

Dorsal fin-rays VI-I, 11 or 12; anal fin-rays I, 11 or 12; pectoral fin-rays 18 or 19; vertebrae 10+16=26; gill-rakers on lower limb of first arch 9; scales 60 to 65 in a longitudinal series, 18 to 23 in a transverse series. For the further description see Yanagisawa (1976).

3. *Amblyeleotris japonica* Takagi

(Japanese name: Date-haze)

(Pl. II-C)

Amblyeloetris japonicus Takagi, 1957, p. 105, pls. 5–A and B.
Amblyeleotris japonica Masuda, Araga et Yoshino, 1975, p. 274, pl. 90–I.
Amblyeleotris japonica Yanagisawa, 1976, Type B, p. 155, fig. 11–B.

Material examined; Eighteen specimens from Shirahama, Wakayama Prefecture, sand and coral rubble bottom, 3 m to 6 m depth, 27 December 1972, 27 March 1973, 6, 10 and 29 April 1973, 29 July 1973, 14 and 15 November 1973, 8 and 15 May 1974. Three specimens from Okikozima Island in Kagoshima Bay, substratum and depth not certain, 5 September 1972, collected by the member of the Marine Ecological Researching Society of Kagoshima University.

Description

Counts and proportional measurements are shown in Table 8. Dorsal fin-rays VI-I, 12 to 14; anal fin-rays, I, 13 or 14; pectoral fin-rays 18 to 20; vertebrae 10+16=26; gill-rakers on lower limb of first arch 8 to 10; scales 74 to 81 in a longitudinal series; 20 to 24 in a transverse series.

Head roundish, body elongate, compressed. Interorbital space very narrow; snout obtuse, as long as eye diameter; anterior nostril with a short tube positioned about

Table 8. Counts and proportional measurements of *Amblyeleotris japonica* and *A. steinitzi*. Proportional measurements are expressed in thousandths of standard length. Average is shown in a parenthesis and the number of specimens in a bracket.

	Amblyeleotris japonica	*Amblyeleotris steinitzi*	
Number of specimens	21	17 (Nansei Islands)	5 (Palau Islands)
Sex (♀+♂)	9+10	7+9	3+2
Standard length (mm)	18.8–82.9 (51.9)	18.2–53.9 (35.1)	20.2–40.9 (30.3)
Total length	1290–1460 (1370)	1280–1360 (1300)	1282–1331 (1304)
Body height	161– 182 (173)	182– 205 (198)	198– 218 (206)
Head length	242– 292 (268)	276– 337 (308)	294– 324 (308)
Eye diameter	58– 96 (70)	66– 104 (81)	84– 93 (90)
Interorbital width	5– 26 (16)	7– 33 (16)	12– 27 (20)
Snout length	52– 76 (60)	49– 92 (68)	57– 65 (62)
Caudal peduncle length	130– 165 (149)	151– 172 (162)	156– 186 (169)
Caudal peduncle height	89– 107 (98)	97– 120 (110)	103– 116 (110)
First dorsal fin length	137– 336 (207)	126– 232 (181)	156– 203 (176)
Second dorsal fin length	129– 290 (190)	154– 260 (188)	153– 212 (178)
Second dorsal fin base	288– 346 (324)	258– 311 (279)	267– 288 (277)
Anal fin length	136– 227 (181)	154– 239 (182)	170– 201 (186)
Anal fin base	253– 332 (300)	226– 274 (249)	238– 265 (252)
Pectoral fin length	235– 290 (265)	251– 336 (297)	276– 310 (299)
Pelvic fin length	232– 302 (261)	263– 299 (281)	263– 308 (277)
Predorsal length	300– 372 (322)	333– 385 (358)	355– 392 (372)
Presecond dorsal length	504– 565 (521)	541– 581 (557)	538– 575 (555)
Prepelvic length	301– 357 (325)	334– 407 (357)	330– 348 (339)
Preanal length	532– 592 (564)	559– 614 (590)	581– 599 (591)
Dorsal fin rays	VI-I, 12[2], 13[18], 14[1]	VI-I, 11[2], 12[15]	VI-I, 12[5]
Anal fin rays	I, 13[5], 14[16]	I, 12[17]	I, 12[5]
Pectoral fin rays	18[20], 19[17], 20[3]	18[4], 19[20], 20[10]	19[5], 20[4], 21[1]
Scales in longitudinal series	74– 87 (81)	65– 77 (70)	67– 72 (69)
Scales in transverse series	20– 24 (22)	19– 22 (20)	21– 22 (21)

halfway between lip and the anterior margin of eye, posterior nostril without rim positioned close to the anterior margin of eye. Mouth oblique, jaws subequal and upper jaw reaching a point below the posterior part of eye. On upper jaw a single external series of about 15 slender teeth on each side, those in front larger, and an inner band of several irregularly arranged series of small teeth. On lower jaw a cluster of villiform teeth in front, and a single series of slender teeth posteriorly, inside of which 2 to 4 recurved canine-like teeth (Yanagisawa, 1976, fig. 10). No teeth on vomer; the frontal part of vomer not protruding downward. Tongue rounded, glossohyal bone narrow fan-shaped. Gill-opening very wide, extending to below a point about halfway between the posterior margin of eye and the anterior margin of opercle; isthmus narrow; no fleshy flap on the inner margin of shoulder girdle. No spine on preopercle. Anterior oculoscapular canal with pores B′(6/6), C(6), D(6), E(6), F(6), G(6), H′(6); posterior oculoscapular canal with pores K′(6), L′(6); preopercular canal with pores M′(6), N(6), O′(6). Sensory papillae on head poorly defined (Takagi, 1957, fig. 2).

First dorsal fin lower than body, 3rd spine longest. Second dorsal fin as high as first one. Anal fin as high as second dorsal fin, its origin at a point below 1st or 2nd soft ray of second dorsal fin. Caudal fin oblong, longer than head. Pectoral fin without free silky rays, slightly pointed posteriorly, reaching a line vertically through the origin of second dorsal fin. Pelvic fins I, 5, 4th ray longest, uniting membrane rudimentary, UM-value less than 0.15 in adult; rudimentary pelvic frenum present.

Scales on the anterior half of body small and cycloid, becoming larger and ctenoid posteriorly. Head naked, small scales present or absent on the median part of nape. Pectoral base scaleless except in rare cases, thorax scaly in adult.

Colour of body creamy white or pale yellow with five broad transverse bands of dark brown, slightly inclined forward and downward; anteriormost band running from nape to opercle, second from first dorsal to pelvic fin, third and fourth from second dorsal to anal fin, fifth on caudal peduncle; these bands narrower than or as broad as the interspace. Some part of chin and jungular region dark brown. A spot of the same colour on the area of just behind jaw edge. Small spots and streaks of pale blue-purple on head and pectoral base. First and second dorsal fins pale yellow with many spots of pale blue-purple, a narrower stripe of orange at the lower quarter. The basal part of anal fin pale yellow with spots of pale blue-purple, a dark brown streak along the middle part, and the distal half dusky. Pectoral fins colourless. Pelvic rays yellow or orange, membrane blue. Caudal fin semitransparent or pale yellow, with a broad dark brown stripe extending from caudal base to the lower part and spots and streaks of pale blue-purple at the distal part.

4. *Amblyeleotris steinitzi* (Klausewitz)

(Japanese name: Hime-datehaze)

(Pl. II-D)

Crytocentrus steinitzi Klausewitz, 1974a, p. 70, figs. 1 and 2.
Amblyeleotris japonica Yanagisawa, 1976, Type A, p. 155, fig. 11–A.

Material examined: One specimen from Yomitan, Okinawa Island, Nansei Islands, sand and coral rubble bottom, 2 m depth, 6 July 1970, collected by E. Harada. On specimen from Oh-zima, Okinawa Island, Nansei Islands, sand and coral rubble bottom, 2 m depth, 8 February 1973. One specimen from Shioya Bay, Okinawa Island, Nansei Islands, sand and coral rubble bottom, 2 m depth, 8 February 1973. Five specimens from Akasaki Reef, Yoron Island, Nansei Islands, sand and coral rubble bottom, 1.5 m to 4 m depth, 15 June 1973, 28 and 31 October 1973. Nine specimens from Sesoko Island, Okinawa Island, Nansei Islands, sand and coral rubble bottom, 4 m to 7 m depth, 22 October 1974. Five specimens from Malakal Bay, Malakal Island, Palau Islands, coral sand bottom, 1.5 m to 2.5 m depth, 3 November 1976.

Description

Counts and proportional measurements are shown in Table 8. Dorsal fin-rays VI-I, 11 or 12; anal fin-rays I, 12; pectoral fin-rays 18 to 21; vertebrae 10+16=26; gill-rakers on lower limb of first arch 8 to 10; scales 65 to 77 in a longitudinal series; 19 to 22 in a transverse series.

Head roundish, body elongate, compressed. Interobital space very narrow; snout obtuse, slightly shorter than eye diameter; anterior nostril with a short tube positioned about halfway between lip and the anterior margin of eye, posterior nostril without rim positioned close to the anterior margin of eye. Mouth oblique, jaws subequal and upper jaw reaching a point below the middle part of eye or a little more. On upper jaw a single external series of about 15 slender teeth on each side, those in front larger, and an inner band of several irregularly arranged series of small teeth. On lower jaw a single external series of about 6 pointed teeth on each side, and an inner band of 3 or 4 irregularly arranged series of small teeth in front and one series of slender teeth posteriorly, inside of which 1 to 3 canine-like teeth on each side (Fig. 19-C). No teeth on vomer; the frontal part of vomer not protruding downward. Tongue rounded, glossohyal bone narrow fan-shaped. Gill-opening very wide, extending to below a point about halfway between the posterior margin of eye and the anterior magin of opercle; isthmus narrow; no fleshy flap on the inner margin of shoulder girdle. No spine on preopercle. Canal pores and sensory papillae on head are shown in Fig. 18-A. Anterior oculoscapular canal with pores B′(6/6), C(6), D(6), E(6), F(6), G(6), H′(6); posterior oculoscapular canal with pores K′ (6), L′(6); preopercular canal with pores M′(6), N(6), O′(6). Sensory papillae on head poorly defined.

First dorsal fin lower than body, 2nd to 4th spine longest. Second dorsal fin as high as first one. Anal fin as high as second dorsal fin, its origin at a point below 2nd soft ray of second dorsal fin. Caudal fin oblong, as long as head. Pectoral fin without free silky rays, slightly pointed posteriorly, reaching a line vertically

through the origin of anal fin. Pelvic fins I, 5, 4th ray longest, uniting membrane rudimentary, UM-value less than 0.3 in adult; pelvic frenum absent.

Scales on the anterior half of body small and cycloid, becoming larger and ctenoid posteriorly. Head naked, the median part of nape and pectoral base with small scales or scaleless. Thorax scaly in adult.

Colour of body creamy white with five broad transverse brown bands, slightly inclined forward and downward; anteriormost band running from nape to opercle, second from first dorsal to pelvic fin, third and fourth from second dorsal to anal fin, fifth on caudal peduncle; these bands narrower than or as broad as the interspace. A narrow vertical band and a speckle of the same colour below eye and at caudal base respectively. Cheek and pectoral base with small pale blue spots, jungular region pale brown. First and second dorsal fin semitransparent, with pale yellow spots and streaks, the base of second dorsal fin with a yellow stripe. Anal fin pale yellow, the basal part whitish, a testaceous streak sandwiched in between two pale blue stripes along the middle, and the distal half dark or semitransparent. Pectoral fin colourless, pelvic fin with irregular yellow bands. Membrane of caudal fin pale yellow, with a brown streak on the lower part.

5. *Amblyeleotris ogasawarensis* n. sp.

(Japanese name: Minami-datehaze)

(Fig. 16, Pl. II-E)

Amblyeleotris japonica Yanagisawa, 1976, Type C, p. 161, fig. 11-C.

Holotype: SMBL Type-304, adult female, 63.2 mm, Futami Bay, Chichi-zima Island, Ogasawara Islands, sand and coral rubble bottom, 6 m depth, 13 April 1974.

Paratypes: SMBL Type-305, adult male, 71.6 mm, and adult male, 63.7 mm, same locality and date as holotype. SMBL Type-306, adult female, 68.5 mm, same locality as holotype, sand and coral rubble bottom, 10 m depth, 15 April 1974. SMBL Type-307, young, 32.1 mm, 32.1 mm, 28.3 mm, 25.0 mm, same locality as holotype, sand and coral rubble bottom, 10 m depth, 17 April 1974. SMBL Type-308, adult female, 54.5 mm, Sesoko Island, Okinawa Island, Nansei Islands, sand bottom at outer reef slope, 35 m depth, 20 March 1976, collected by T. Yoshino.

Description

Counts and proportional measurements are shown in Table 9. Dorsal fin-rays VI-I, 13 or 14; anal fin-rays I, 13 or 14; pectoral fin-rays 18 to 20; vertebrae 10+16=26; gill-rakers on lower limb of first arch 10; scales 80 to 94 in a longitudinal series; 25 to 28 in a transverse series.

Head roundish, body elongate, compressed. Interorbital space very narrow; snout obtuse, as long as eye diameter; anterior nostril with a short tube positioned

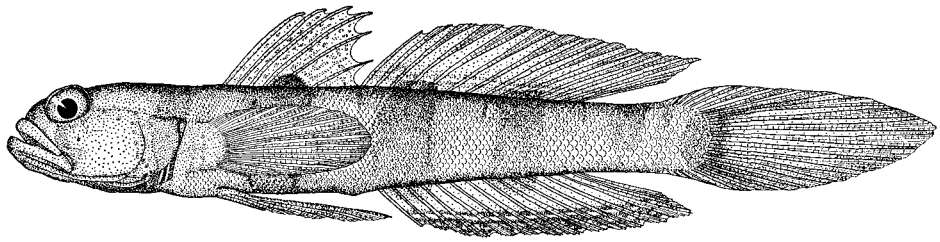

Fig. 16. *Amblyeleotris ogasawarensis* n. sp., Holotype, SMBL Type-304, female, 63.2 mm in standard length.

about halfway between lip and the anterior margin of eye, posterior nostril without rim postioned close to the anterior margin of eye. Mouth oblique, jaws subequal and upper jaw reaching a point below the middle part of eye. On upper jaw a single external series of about 15 slender teeth on each side, those in front larger, and an inner band of two or three series of small teeth. On lower jaw a single external series of about 5 pointed teeth on each side and an inner band of 3 or 4 irregularly arranged series of small teeth in front, and a single series of slender teeth posteriorly, inside of which 1 to 4 canine-like teeth on each side (Fig. 19–D). No teeth on vomer; the frontal part of vomer not protruding downward. Tongue rounded, glossohyal bone narrow fan-shaped. Gill-opening very wide, extending to a point below halfway between the posterior margin of eye and the anterior margin of opercle or a little more; isthmus narrow; no fleshy flap on the inner margin of shoulder girdle. No spine on preopercle. Canal pores and sensory papillae on head are shown in Fig. 18–B. Anterior oculoscapular canal with pores B′(5/5), C(5), D(5), E(5), F(5), G(5), H′(5); posterior oculoscapular canal with pores K′(5), L′(5); preopercular canal with pores M′(5), N(5), O′(5). Sensory papillae on head poorly defined.

First dorsal fin lower than body, fourth spine longest. Second dorsal fin as high as first dorsal fin. Anal fin as high as second dorsal fin, its origin at a point below 1st or 2nd soft ray of second dorsal fin. Caudal fin oblong, longer than head. Pectoral fin without free silky rays, reaching a line vertically through the origin of anal fin. Pelvic fins I, 5, 4th ray longest, uniting membrane not fully developed, UM-value 0.40 to 0.74 in adult; pelvic frenum absent.

Scales on the anterior half of body small and cycloid, becoming larger and ctenoid posteriorly. Head naked, the median part of nape and pectoral base without scales. Thorax scaly or not.

Colour of body creamy white or pale yellow with five broad transverse brown bands, slightly inclined forward and downward; anteriormost band running from nape to opercle, second from first dorsal to pelvic fin, third and fourth from second dorsal to anal fin, fifth on caudal peduncle; these bands narrower than or as broad as the interspace; second to fourth bands having short continuations into the basal part of dorsal and anal fins. A narrow vertical band of the same colour from eye to the posterior end of jaw. Head and pectoral base scattered with many small blue-

Table 9. Counts and proportional measurements of *Amblyeleotris ogasawarensis*. Proportional measurements are expressed in thousandths of standard length.

	Holotype SMBL 304	Paratypes			
		SMBL 305	SMBL 306	SMBL 307	SMBL 308
Sex	♀	♂	♂	♀	♀
Standard length (mm)	63.2	71.6	63.7	68.5	54.5
Dorsal fin rays	VI-I, 13	VI-I, 13	VI-I, 14	VI-I, 13	VI-I, 13
Anal fin rays	I, 13	I, 13	I, 14	I, 13	I, 13
Pectoral fin rays	19–19	20–20	19–19	19–19	18–18
Scales in longitudinal series	89	94	84	90	80
Scales in transverse series	28	28	26	28	25
Total length	1383	1390	1350	1382	1325
Body height	171	191	171	183	174
Head length	265	237	273	254	281
Eye diameter	68	59	72	66	73
Interorbital width	17	14	16	23	13
Snout length	63	64	64	67	68
Caudal peduncle length	150	151	134	137	161
Caudal peduncle height	108	103	107	107	97
First dorsal fin length	199	193	173	187	163
Second dorsal fin length	226	218	176	213	183
Second dorsal fin base	329	342	325	330	316
Anal fin length	198	187	190	196	182
Anal fin base	311	307	313	297	281
Pectoral fin length	267	254	235	267	264
Pelvic fin length	245	265	220	238	226
Predorsal length	323	323	334	344	347
Presecond dorsal length	529	525	535	544	532
Prepelvic length	302	312	311	322	330
Preanal length	553	545	565	568	596

purple spots. A deep red spot just behind jaw which can be seen only when mouth is opened. First dorsal fin pale blue at the basal half, and semitransparent or faint yellow at the distal half, with spots and vermiculated specks of yellow or orange. Second dorsal fin semitransparent or pale yellow with a longitudinal streak and spots of blue at the basal part. Anal fin pale yellow at the basal half and pale brown at the distal edge, and along the middle of anal fin a dark brown stripe. Pectoral fin colourless. Pelvic fins faint brown at the basal half and pale yellow at the distal half, irregular pale blue steaks along the rays. Caudal fin semitransparent or pale yellow, with a large brown speckle at the basal part, followed by a pair of lateral streaks of the same colour extending backward from the upper and lower edges of the speckle; pale brown streaks along the rays and indistinct spots of blue-purple at the basal part.

6. *Amblyeleotris guttata* (Fowler)

(Japanese name: Yamabuki-haze)

(Fig. 17, Pl. II-F)

Pteroculiops guttatus Fowler, 1938, p. 133.

Material examined: One specimen from Kuroshima Island, Nansei Islands, coral sand bottom, 20 m depth, 28 July 1976, collected by T. Yoshino. Two specimens from Anae, Guam Island, coral and sand bottom, 10 m depth, 11 November 1976.

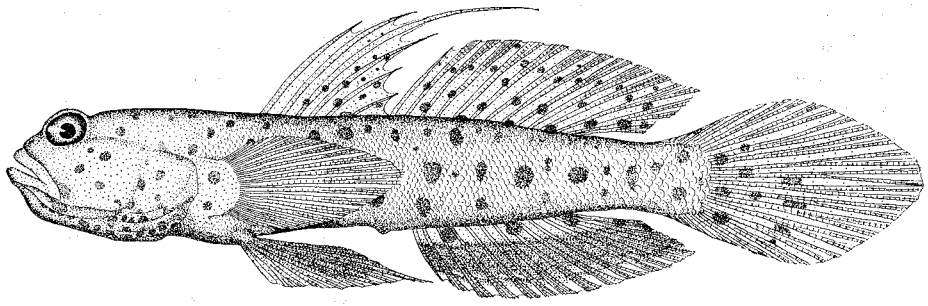

Fig. 17. *Amblyeleotris guttata*, female, 73.4 mm in standard length.

Description

Counts and proportional measurements are shown in Table 10. Dorsal fin-rays VI-I, 12 or 13; anal fin-rays I, 12; pectoral fin-rays 19 or 20; vertebrae 10+16=26; gill rakers on lower limb of first arch 10; scales 66 to 83 in a longitudinal series; 22 to 24 in a transverse series.

Head roundish, body elongate, compressed. Interorbital space very narrow; snout obtuse, as long as eye diameter; anterior nostril with a short tube positioned about halfway between lip and the anterior margin of eye, posterior nostril without rim positioned close to the anterior margin of eye. Mouth oblique, jaws subequal and upper jaw reaching a point below the middle of eye. On upper jaw a single external series of about 15 slender teeth on each side, two of those in front enlarged, and an inner band of several irregularly arranged series of small teeth. On lower jaw a cluster of villiform teeth in front, and a single series of slender teeth posteriorly, inside of which 2 to 4 recurved canine-like teeth. No teeth on vomer; the frontal part of vomer not protruding downward. Tongue rounded, glossohyal bone narrow fan-shaped. Gill-opening very wide, extending to a point below halfway between the posterior margin of eye and the anterior margin of opercle; isthmus narrow; no fleshy flap on the inner margin of shoulder girdle. No spine on preopercle. Canal pores and sensory papillae on head are shown in Fig. 18–C. Anterior oculoscapular canal with pores B′(2/2), C(2), D(2), E(2), F(2), G(2), H′(2); posterior oculoscapular canal with pores K′(2), L′(2); preopercular canal with pores M′(2), N(2), O′(2).

Table 10. Counts and proportional measurements of *Amblyeleotris guttata*. Proportional measurements are expressed in thousandths of standard length.

	Palau Islands		Nansei Islands
Sex	♀	♀	♀
Standard length (mm)	73.4	50.2	54.8
Dorsal fin rays	VI-I, 12	VI-I, 13	VI-I, 12
Anal fin rays	I, 12	I, 12	I, 12
Pectoral fin rays	19–19	19–20	19–19
Scales in longitudinal series	83	78	66
Scales in transverse series	23	24	22
Total length	1356	1404	1378
Body height	193	201	212
Head length	282	301	301
Eye diameter	65	70	73
Interorbital width	25	22	22
Snout length	75	80	64
Caudal peduncle length	166	179	150
Caudal peduncle height	108	108	106
First dorsal fin length	393	317	263
Second dorsal fin length	230	199	203
Second dorsal fin base	281	201	290
Anal fin length	229	201	201
Anal fin base	245	255	237
Pectoral fin length	277	297	307
Pelvic fin length	332	335	310
Predorsal length	375	345	336
Presecond dorsal length	354	534	542
Prepelvic length	334	386	330
Preanal length	608	594	593

Sensory papillae on head poorly defined.

First dorsal fin lower than body, 3rd spine filamentous. Second dorsal fin as high as first one. Anal fin as high as second dorsal fin, its origin at a point below 2nd soft ray of second dorsal fin. Caudal fin oblong, longer than head. Pectoral fin without free silky rays, slightly pointed posteriorly, reaching a line vertically through the origin of second dorsal fin. Pelvic fins I, 5, 4th ray longest, uniting membrane rudimentary, UM-value less than 0.15; frenum absent.

Scales on the anterior half of body small and cycloid, becoming larger and ctenoid posteriorly. Head naked, 3 to 11 small scales on the median part of nape. Pectoral base, thorax and belly scaly.

Colour of body creamy white, head and body scattered with bright yellow spots. The areas just behind jaws and along the median line of chin pale orange. The lower half of gill membrane with many light blue spots. Thorax and isthmus

umber. The anterior half of belly with umber part extending to the middle of body, forming a triangle in a lateral view. The posterior half of first dorsal fin with about 10 orange yellow spots, and second dorsal fin with about 30 spots of the same colour. Anal fin with a broad longitudinal umber band along the middle part both side of which are bordered with disconnected reddish brown lines; four bright yellow spots along the base. Pelvic base and the basal half of pelvic fins umber. Pectoral fin colourless. About 10 orange or reddish orange spots on the basal half of caudal fin.

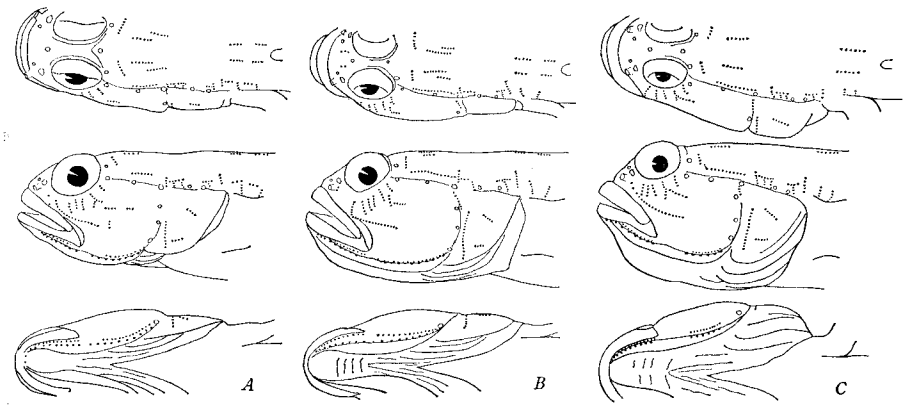

Fig. 18. Canal pores and sensory papillae. A- *Amblyeleotris steinitzi*, B- *Amblyeleotris ogasawarensis*, C- *Amblyeleotris guttata*.

Remarks on the species of genus Amblyeleotris

In my previous paper (Yanagisawa, 1976), three geographical types of *Amblyeleotris japonica* (Types A, B and C) were described from the Nansei Isalnds, Honshu and Kyushu, and the Ogasawara Islands, and were suggested to be assigned to the variations at subspecific level as they have fairly remarkable differences in the meristic and proportional characters with one another. However, Mr. T. Yoshino recently caught one specimen of Type C from Sesoko Island, one of the Nansei Islands, where I had collected only the specimens of Type A. Now that the overlapping of the distribution of these two types was confirmed, it seems appropriate for them to be separated from *A. japonica* (=Type B) and devided into two distinct species. Type A of *A. japonica*, which is clarified to be the same as the lately described species *Cryptocentrus steinitzi* Klausewitz (1974a) from the Red Sea and the Palau Islands, is described under the name *Amblyeleotris steinitzi* in this paper, and Type C is described under the name *A. ogasawarensis*. *A. ogasawarensis* can be distinguished from *A. steinitzi* by greater number of dorsal and anal soft rays (13 or 14, 11 or 12; 13 or 14, 12) and of scales (80 to 94, 65 to 77), and from *A. japonica* by lack of pelvic frenum and more developed uniting membrane of pelvic fins (UM-value 0.40 to 0.74, less than 0.15). This species also closely resembles to *Cryptocentrus sungami* Klausewitz (1969); five transverse bands on body, 13 dorsal soft rays and 13 anal soft rays common to two

species, though the former has no pelvic frenum and not fully developed uniting membrane and the latter has united pelvic fins. *A. japonica* is, according to our present knowledge, an endemic species to Honshu to Kyushu in Japan, after the separation of Types A and C as distinct species from this species.

VII. *Mahidolia* H.M. Smith

(H.M. Smith et Koumans, 1932, p. 255)

Body compressed, head stumpy. Scales 33 to 50 in a longitudinal series, ctenoid posteriorly, cycloid anteriorly. Head naked, the median part of nape covered with small scales or scaleless. Interorbital space very narrow. Snout obtuse, about as long as eye diameter. Mouth oblique, upper jaw elongated to the posterior border of preopercle in male (or both sexes ?). Teeth on upper jaw in 3 or 4 series, and on lower jaw in several series. Tongue rounded. Gill-opening wide, exceeding a point below the posterior margin of preopercle. Sensory papillae on head fairly well developed, making reticulation on cheek. Dorsal fin-rays VI-I, 10; anal fin-rays I, 9. Pelvic fins united. Caudal fin rounded or oblong, as long as or slightly shorter than head.

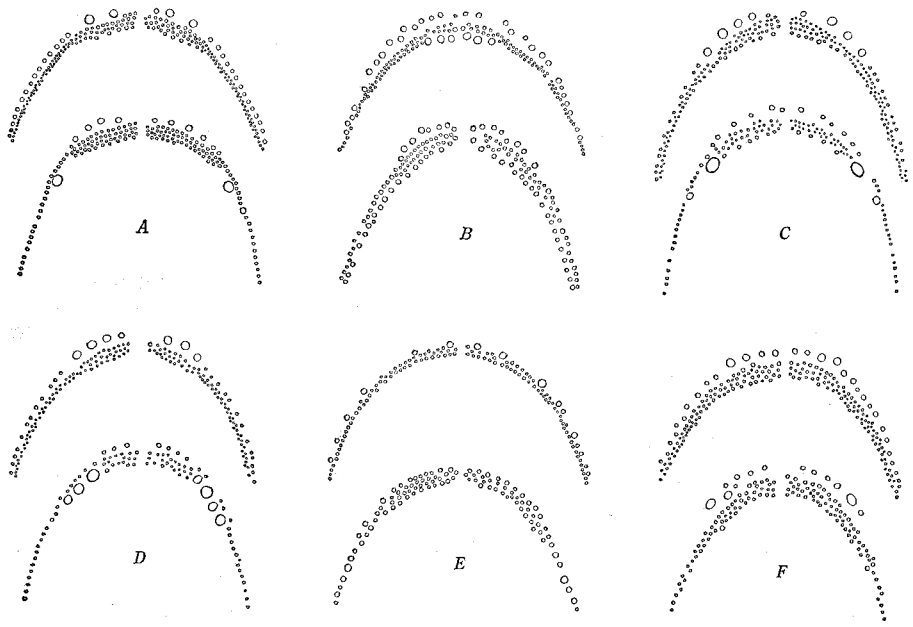

Fig. 19. Diagrammatic teeth arrangement in upper jaw (upper) and lower jaw (lower). A- *Ctenogobiops crocineus*, B- *Tomiyamichthys oni*, C- *Amblyeleotris steinitzi*, D- *Amblyeleotris ogasawarensis*, E-*Mahidolia mystacina*, F- *Acentrogobius pflaumi*.

1. *Mahidolia mystacina* (Valenciennes)

(Japanese name: Kasuri-haze)

(Fig. 20, Pl. II-G)

Gobius mystacinus Valenciennes, in Cuiver et Valenciennes, 1837, p. 124.
Waitea parvida Tanaka, 1915, p. 567.
Waitea mystacina Herre, 1927, p. 207.
Mahidolia normani H.M. Smith et Koumans, 1932, p. 256, pl. 23.
Waitea mystacina Tomiyama, 1936, p. 77. fig. 28.
Waitea mystacina Matsubara, 1955, p. 834.
Waitea mystacina J.L.B. Smith, 1959, p. 213.
Mahidolia mystacina Masuda, Araga et Yoshino, 1975, p. 277, pl. 92-C.

Material examined: Fifteen specimens from Shirahama, Wakayama Prefecture, mud bottom, 3 m to 10 m depth, 27 September 1973, 11 December 1975, 10 and 13 May 1976.

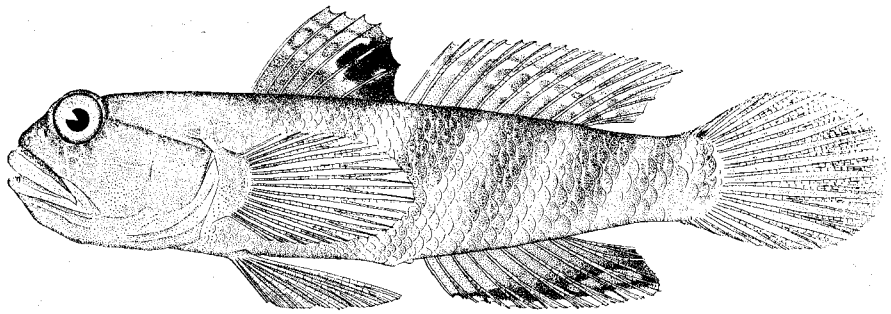

Fig. 20. *Mahidolia mystacina*, female, 36.3 mm in standard length.

Description

Counts and proportional measurements are shown in Table 11. Dorsal fin-rays VI-I, 10; anal fin-rays I, 9; pectoral fin-rays 15 to 17; vertebrae 10+16=26; gill-rakers on upper limb of first arch 9 or 10; scales 33 to 37 in a longitudinal series, 12 to 14 in a transverse series.

Head stumpy, body elongate, compressed. Interorbital space very narrow; snout obtuse, as long as eye diameter; anterior nostril with a short tube positioned close to lip, posterior nostril without rim positioned an upper quarter between the anterior margin of eye and lip. Mouth oblique, jaws subequal, and upper jaw reaching the posterior border of preopercle in male and reaching a point below the posterior end of eye in female (Fig. 21). On upper jaw a single external series of larger inwardly recurved teeth and an inner band of small teeth, two series in front and one series posteriorly. On lower jaw a band of several irregularly arranged small teeth in front, and a single series of slightly larger teeth posteriorly (Fig. 19-E). No teeth on vomer; the frontal part of vomer protruding downward. Tongue rounded, glossohyal bone narrow fan-shaped. Gill-opening wide, slightly exceeding a point

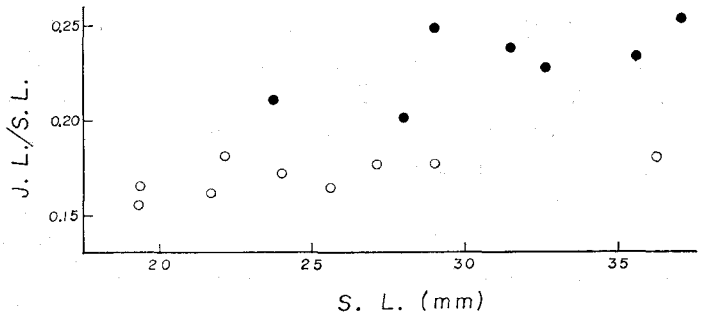

Fig. 21. Sexual dimorphism in upper jaw length in *Mahidolia mystacina*. J.L- upper jaw length, S.L- standard length ●- male, ○- female or young.

Table 11. Counts and proportional measurements of *Mahidolia mystacina*. Proportional measurements are expressed in thousandths of standard length. Average is shown in a parenthesis and the number of specimens in a bracket.

Number of specimens	8	7
Sex	female	male
Standard length (mm)	19.3–29.0 (23.5)	23.8–37.1 (31.1)
Total length	1300–1371 (1323)	1290–1344 (1308)
Body height	238– 254 (247)	228– 253 (241)
Head length	309– 344 (329)	322– 340 (332)
Eye diameter	82– 98 (94)	77– 86 (83)
Interorbital width	10– 21 (16)	14– 22 (17)
Snout length	77– 97 (88)	79– 97 (90)
Upper jaw length	155– 181 (169)	201– 254 (230)
Caudal peduncle length	176– 212 (197)	181– 204 (189)
Caudal peduncle height	104– 119 (110)	110– 118 (113)
First dorsal fin length	189– 262 (235)	197– 235 (218)
Second dorsal fin length	192– 258 (216)	197– 240 (222)
Second dorsal fin base	255– 271 (262)	255– 273 (267)
Anal fin length	188– 226 (209)	200– 221 (211)
Anal fin base	192– 213 (203)	200– 216 (205)
Pectoral fin length	293– 356 (326)	289– 315 (305)
Pelvic fin length	238– 317 (261)	233– 265 (246)
Predorsal length	373– 394 (382)	368– 390 (380)
Presecond dorsal length	575– 604 (591)	572– 617 (590)
Prepelvic length	324– 358 (349)	337– 374 (359)
Preanal length	609– 627 (617)	606– 636 (621)
Dorsal fin rays	VI-I, 10[8]	VI-I, 10[7]
Anal fin rays	I, 9[8]	I, 9[7]
Pectoral fin rays	15[1], 16[9], 17[6]	16[13], 17[1]
Scales in longitudinal series	33– 36 (35)	34– 37 (35)
Scales in transverse series	12– 14 (13)	12– 14 (13)

below the posterior margin of preopercle; isthmus moderate; no fleshy flap on the inner margin of shoulder girdle. No spine on preopercle. Canal pores and sensory papillae on head are shown in Fig. 22–A. Anterior oculoscapular canal with pores B′(7/7), C(0), D(6), E(7), F(7), G(7), H′(7); posterior oculoscapular canal with pores K′(1), L′(1); preopercular canal with pores M′(7), N(6), O′(7). Sensory papillae on head fairly well developed.

First dorsal fin lower than body, 1st, 2nd, 3rd or 4th spine longest. Second dorsal fin slightly lower than first dorsal fin. Anal fin as high as second dorsal fin, its origin at a point below 1st soft ray of second dorsal fin. Caudal fin rounded, as long as head. Pectoral fin without silky free rays, rounded posteriorly, reaching a line vertically through anus. Pelvic fins I, 5, both fins united, frenum normally developed.

Scales on the anterior half of body small and cycloid, becoming larger and ctenoid posteriorly. Head naked, the median part of nape and pectoral base scaleless. Thorax and belly scaly.

Colour of body dusky with 7 or 8 transverse black bands, inclined forward and downward, from the origin of first dorsal fin to caudal peduncle. Opercle and pectoral base dotted with light brown spots. Membrane of the distal half behind 4th spine of first dorsal fin with a large striking blackish blue dot and yellow stripes fringing it along the distal half of 4th, 5th and 6th spines; other part of first dorsal fin dusky. Second dorsal fin dark brown along the basal part, and dotted with dark brown spots in two or three longitudinal rows along the middle part, the distal part colourless except a light brown stripe along the margin. Anal fin dusky, the distal half blackish. Pelvic fin dusky. Pectoral fin and caudal fin almost colourless.

Remarks

Although Jordan et Seale (1906) established the genus *Waitea* for the specimen from Samoa and gave the name *Waitea mystacina* to it as considering to be agreeable with *Gobius mystacinus* Valenciennes (1837), the figure of the specimen given (Jordan et Seale, 1906, fig. 94) apparently indicates it to be different species from the latter. H.M. Smith (1945) reported that the specimens recorded from Thailand under the name *Mahidolai normani* H.M. Smith et Koumans (1932) was confirmed to be identical with the type specimen of *Gobius mystacinus* and gave the name *Mahidolia mystacina* to them. My specimens agree well with *Mahidolia mystacina*. *Waitia parvida* Tanaka (1915), which was later regarded as a synonym of *Waitea mystacina* by Tomiyama (1936), is apparently identical with *Mahidolia mystacina*.

Mahidolia mystacina shows sexual dimorphism in the length of upper jaw as the genus *Redigobius* does. All the descriptions on this species hitherto recorded have been concerned only with the specimens having elongated jaw extending to the posterior border of preopercle which is characteristic to the male. The elongated jaw has been regarded as one of the important generic characters in these descriptions, but, as the female of this species has not so long jaw as the male, the definition of *Mahidolia* should be amended not to restrict the jaw as elongated.

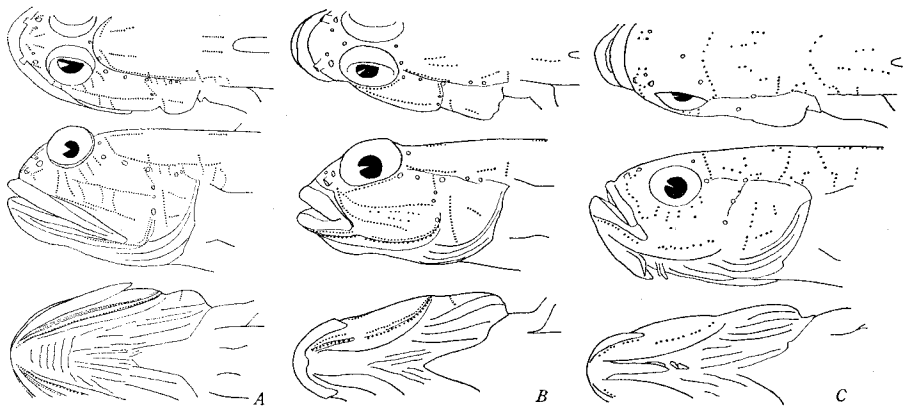

Fig. 22. Canal pores and sensory papillae. A- *Mahidolia mystacina*, B- *Acentrogobius pflaumi*, C- *Vireosa hanae*.

VIII. *Acentrogobius* Bleeker

(Bleeker, 1874, p. 321)

Body elongate, compressed, head slightly compressed or cylindrical. Scales 25 to 45 in a longitudinal series, ctenoid scales, bocoming cycloid on nape, thorax and belly. Preopercle and opercle totally scaled, scaled in the upper parts, or naked. Interorbital space more than to less than eye diameter. Snout obtuse, about as long as eye diameter. Mouth oblique, upper jaw reaching a point below the anterior or posterior part of eye. Teeth on both jaws in several series, the outer enlarged. On lower jaw the outer series extending to the middle of the inner series, the last teeth canine-like. Tongue truncate or scarcely bilobate. Gill-opening not or only a little continued forward below. Sensory papillae on cheek running longitudinally. Dorsal fin-rays VI-I, 6 to 17; anal fin-rays I, 6 to 19. Pelvic fins united. Caudal fin rounded or pointed, as long as or more than head.

1. *Acentrogobius pflaumi* (Bleeker)

(Japanese name: Suzi-haze)

(Pl. II-H)

Gobius pflaumi Bleeker, 1853, p. 42, fig. 3.
Gobius yokohamae Günther, 1877, p. 437.
Ctenogobius virgatulus Jordan et Snyder, 1901, p. 63, fig. 9.
Rhinogobius virgatulus Jordan, Tanaka et Snyder, 1913, p. 344, fig. 295.
Gobius pflaumi Tomiyama, 1936, p. 66.
Rhinogobius pflaumi Matsubara, 1955, p. 830.
Ctenogobius pflaumi Fowler, 1960, p. 107, fig. 6.
Acentrogobius pflaumi Masuda, Araga et Yoshino, 1975, p. 276, pl. 91-G.

Material examined: One specimen from Tomioka, Kumamoto Prefecture, mud bottom, 4 m depth, 31 May 1973. Four specimens from Shirahama, Wakayama Prefecture, mud and sand bottom, 0.5 m to 5 m depth, 19 December 1973 and 23 July 1977. One specimen from Maizuru, Kyoto Prefecture, mud bottom, 5 m depth, 21 March 1974.

Description

Counts and proportional measurements are shown in Table 12. Dorsal fin-rays VI-I, 10; anal fin-rays I, 9 or 10; pectoral fin-rays 15 to 17; vertebrae 10+16= 26; gill-rakers on upper limb of first arch 7 or 8; scales 27 to 29 in a longitudinal series, 9 in a transverse series.

Head cylindrical, body elongate, compressed. Interorbital space very narrow; snout obtuse, about as long as eye diameter; anterior nostril with a short tube positioned close to lip, posterior nostril without rim positioned close to the anterior margin of eye. Mouth oblique, jaws subequal and extending to a point below the anterior part of eye. On upper jaw a single external series of about 15 slightly larger teeth on each side, and an inner bands of small teeth, about 4 series in front and 2 series posteriorly. On lower jaw an inner band of small teeth, about 4 series in front and 1 or 2 series posteriorly, and a single external series of about 7 larger teeth extending to the middle of inner band, its terminal 1 or 2 teeth canine-like on each side or not (Fig. 19–F). No teeth on vomer; the frontal part of vomer not protruding downward. Tongue truncate, glossohyal bone narrow fan-shaped. Gill-opening not wide, only exceeding the lower end of pectoral base; isthmus wide; no fleshy flap on the inner margin of shoulder girdle. No spine on preopercle. Canal pores and sensory papillae on head are shown in Fig. 22–B. Anterior oculoscapular canal with pores B′(6/6), C(6), D(6), E(6), F(6), G(6), H′(6); posterior oculoscapular canal with pores K′(6), L′(6); preopercular canal with pores M′(6), N(6), O′(6). Sensory papillae on cheek with three defined longitudinal series.

First dorsal fin lower than body, 3rd spine longest. Second dorsal fin lower than body. Anal fin as high as second dorsal fin, its origin at a point below 1st soft ray of second dorsal fin. Caudal fin rounded, slightly shorter than head. Pectoral fin without silky free rays, rounded posteriorly, nearly reaching anus. Pelvic fin I, 5, both fins united, pelvic frenum normally developed.

Scales all ctenoid, except the anteriormost small cycloid scales. Head naked, 1 to 10 small scales on the median part of nape. Pectoral base, thorax and belly scaly.

Colour of body much variable in life. Dorsal part of body somewhat dusky, ventral part whitish. Along the middle of body 5 dark brown blots, first below first dorsal fin, second and third below second dorsal fin, fourth on caudal peduncle, fifth on caudal fin base. Five obscure dark brown dots along the median part of dorsum from the origin of first dorsal fin to caudal peduncle. About 5 undefined narrow longitudinal bands of dark brown on the upper and middle part of body A short vertical dark brown bar running from eye to upper jaw, and a longitudinal dark

Table 12. Counts and proportional measurements of *Acentrogobius pflaumi* and *Vireosa hanae*. Proportional measurements are expressed in thousandths of standard length. Average is shown in a parenthesis and the number of specimens in a bracket.

	Acentrogobius pflaumi	*Vireosa hanae*
Number of specimens	6	6
Sex (♀+♂)	3+3	3+3
Standard length (mm)	35.1–47.1 (40.6)	74.1–94.0 (84.1)
Total length	1240–1292 (1259)	1525–2231 (1855)
Body height	167– 197 (181)	134– 143 (137)
Head length	251– 298 (276)	199– 217 (207)
Eye diameter	70– 85 (76)	47– 57 (52)
Interorbital width	11– 15 (14)	67– 76 (73)
Snout length	55– 76 (67)	48– 57 (53)
Caudal peduncle length	189– 199 (194)	86– 95 (90)
Caudal peduncle height	96– 105 (101)	89– 100 (94)
First dorsal fin length	118– 146 (134)	135– 166 (150)
Second dorsal fin length	134– 190 (157)	128– 196 (154)
Second dorsal fin base	264– 285 (277)	423– 441 (431)
Anal fin length	126– 157 (141)	112– 140 (128)
Anal fin base	226– 259 (245)	375– 396 (383)
Pectoral fin length	215– 262 (236)	127– 140 (132)
Pelvic fin length	172– 201 (190)	136– 184 (160)
Predorsal length	331– 372 (348)	255– 274 (267)
Presecond dorsal length	518– 556 (540)	457– 483 (474)
Prepelvic length	279– 311 (302)	212– 228 (221)
Preanal length	556– 580 (569)	525– 552 (539)
Dorsal fin rays	VI-I, 10[6]	VI-I, 24[2], 25[4]
Anal fin rays	I, 9[1], 10[5]	I, 22[2], 23[3], 24[1]
Pectoral fin rays	15[2], 16[2], 17[8]	22[2], 23[9], 24[1]
Scales in longitudinal series	27– 29 (28)	ca. 125
Scales in transverse series	9 (9)	ca. 38

brown stripe along the middle of cheek and opercle. Cheek, opercle and body scattered with blue small spots. A longitudinal bar along the middle of the posterior half of first dorsal fin. Second dorsal fin with two rows of orange-yellow speckles. The distal margin of both dorsal fins dusky orange. Anal fin with a yellowish band at its basal part, the distal part dusky. Pectoral fin transparent or pale yellow. Pelvic fins bluish white. Caudal fin with several transverse rows of dark brown dots, and undefined reddish orange stripes along rays; the upper and lower margin dusky.

IX. *Vireosa* Jordan et Snyder

(Jordan et Snyder, 1901, p. 38)

Body very much elongate, compressed, head slightly compressed. Scales about

125 in a longitudinal series, all minute cycloid scales. Head and the median part of nape naked. Interorbital space wide. Snout slightly obtuse, as long as eye diameter. Mouth strongly oblique, upper jaw reaching a point below the anterior margin of eye. Teeth on both jaws in 3 or 4 series, several teeth in the outer series of upper jaw and the inner series of lower jaw canine-like. Tongue rounded, very narrow fan-shaped. Chin with a median barbel, followed by some smaller ones or not. Gill-opening wide, extending to a point below the anterior part of opercle. Sensory papillae on head sparse. Dorsal fin-rays VI-I, 24 to 26; anal fin-rays I, 22 to 24. Pelvic fin-rays I, 4, uniting membrane rudimentary, 3rd soft ray longest; pelvic frenum absent. Caudal fin truncate, some of the upper and lower rays with long filaments.

1. *Vireosa hanae* Jordan et Synder

(Japanese name: Hana-haze)

(Pl. II-I)

Vireosa hanae Jordan et Synder, 1910, p. 38, fig. 1.
Vireosa hanae Jordan, Tanaka et Snyder, 1913, p. 337, fig. 286.
Vireosa hanae Tomiyama, 1936, p. 50.
Vireosa hanae Koumans, 1940, p. 140.
Vireosa hanae Koumans, 1953, p. 365, fig. 90.
Vireosa hanae Matsubara, 1955, p. 818.
Vireosa hanae Masuda, Araga et Yoshino, 1975, pl. 90-H.

Material examined: Six specimens from Shirahama, Wakayama Prefecture, sand bottom, 3 m to 5 m depth, 6, 21 and 29 July 1977.

Description

Counts and proportional measurements are shown in Table 12. Dorsal fin rays VI-I, 24 or 25; anal fin-ray I, 22 to 24; pectoral fin-rays 22 to 24; vertebrae 10+16=26; gill-rakers on first arch 7 or 8+17 or 18; scales about 125 in a longitudinal series, about 38 in a transverse series.

Head slightly compressed, body very much elongate, compressed. Interorbital space wider than eye diameter; snout slightly obtuse, as long as eye diameter; anterior nostril with a short tube positioned about an anterior third between lip and the anterior margin of eye, posterior nostril with short rim positioned about halfway between anterior nostril and the anterior margin of eye. Mouth strongly oblique, lower jaw prominent. Jaws extending to a little beyond a point below the anterior margin of eye. Chin with a large median barbel pointing backward, as large as eye diameter, followed by 1 to 3 smaller ones or not. On upper jaw a single external series of about 10 stout canine-like teeth, those in the middle largest, and an inner band of small teeth in 2 or 3 series. On lower jaw a band of 2 or 3 irregularly arranged series of pointed teeth; several teeth in an inner series canine-like, 2 or 3 of which noticeably enlarged, and a few teeth in an outer series slightly enlarged in front

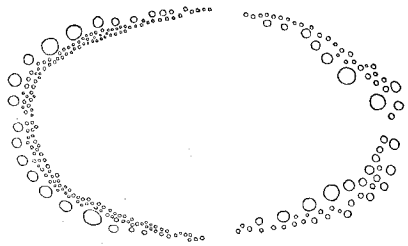

Fig. 23. Diagrammatic teeth arrangement in upper jaw (left) and lower jaw (right) in *Vireosa hanae*.

(Fig. 23). No teeth on vomer; the forntal part of vomer protruding downward. Tongue rounded, glossohyal bone very narrow fan-shaped. Gill-opening wide, extending to a point below about an anterior third of opercle; isthmus narrow; no fleshy flap on the inner margin of shoulder girdle. No spine on preopercle. Canal pores and sensory papillae on head are shown in Fig. 22–C. Anterior oculoscapular canal with pores B′(6/6), C(0), D(5), E(6), F(6), G(0), H′(6); posterior oculoscapular canal absent; preopercular canal with pores M′(6), N(0), O′(6). Sensory papillae on head sparse. First dorsal fin lower than body, 2nd to 5th spine longest. Second dorsal fin lower than body. Anal fin as high as second dorsal fin, its origin at a point below 3rd soft ray of second dorsal fin. Caudal fin truncate, a few upper and lower rays with long ribbon-like filmaments. Pectoral fin short, rounded, extending only to a point below the middle part of first dorsal fin. Pelvic fin I, 4, 3rd ray longest, uniting membrane rudimentary, UM-value less than 0.1; frenum absent.

Scales all minute cycloid, embedded and not imbricating, smaller and farther apart anteriorly, larger and more close posteriorly. Head naked, no scales on the median part of nape, pectoral base and thorax. Belly with minute scales.

The upper part of body greenish blue, the lower part blue with a tinge of violet. A reddish blotch at the lower part of pectoral base, and tip of barbel on chin reddish. A longitudinal line of faint red along a little below the middle of body running from above the origin of anal fin to caudal fin base. The upper and lower parts of eye brilliant blue, between them a horizontal gold band, as wide as iris. Dorsal fins and pelvic fin light blue with a yellowish tint. Anal fin light blue with a wide longitudinal band of pale orange along a upper third. Pectoral fin semitransparent. Caudal fin light blue with pale longitudinal streaks of pale yellow and pale orange.

Distribution and Habitat

Of the gobiid fishes confirmed to be in association with the snapping shrimps, six species *Tomiyamichthys oni, Amblyeleotris japonica, Mahidolia mystacina, Cryptocentrus filifer, Acentrogobius pflaumi* and *Vireosa hanae* have been known to occur in Japanese waters since a long while ago, although little attentions have been paid on the interspecific association of them with the shrimps until recently. Most of their records of occurrence were rendered from various kind of collecting. They have been recorded

Table 13. Occurrence of gobiid fishes associated with snapping shrimps in coastal areas of southern Japan.

		Cryptocentrus singapurensis	*Cryptocentrus flavus*	*Cryptocentrus filifer*	*Mars caeruleomaculatus*	*Mars nigrocellatus*	*Mars albidorsus*	*Vanderhorstia ornatissima*	*Vanderhorstia mertensi*	*Vanderhorstia lanceolata*	*Ctenogobiops crocineus*	*Tomiyamichthys oni*	*Amblyeleotris fasciata*	*Amblyeleotris maculata*	*Amblyeleotris guttata*	*Amblyeleotris japonica*	*Amblyeleotris steinitzi*	*Amblyeleotris ogasawarensis*	*Mahidolia mystacina*	*Acentrogobius pflaumi*	*Vireosa hanae*
Honshu and Kyushu Area	Maizuru, Kyoto			+																+	
	Rinkai, Shirahama			+					+			+				+			+	+	+
	Hatakezima Is., Shirahama			+					+	+						+			+	+	+
	Tsuyazaki, Fukuoka			+																+	
	Nomozaki, Nagasaki															+				+	
	Tomioka, Kumamoto											+				+				+	+
	Matsushima, Kumamoto																			+	
	Chosa, Kagoshima																			+	+
Nansei Islands	Sumiyoshi, Tanegashima Is.				+		+	+	+												
	Wano, Amami-oshima Is.										+						+				
	Akina, Amami-oshima Is.										+										
	Akaogi, Amami-oshima Is.					+		+			+		+				+				
	Nezebu, Amami-oshima Is.				+			+			+		+								
	Kominato, Amami-oshima Is.				+	+					+										
	Seisui, Amami-oshima Is.						+	+			+			+							
	Shiomichi, Kikai Is.				+						+										
	Shiramizu, Kikai Is.				+	+		+													
	Araki, Kikai Is.					+															
	Kametoku, Tokunoshima Is.				+			+			+						+				
	Chahana, Yoron Is.				+	+	+										+				
	Hakibina Beach, Yoron Is.				+	+		+			+										
	Akasaki Reef, Yoron Is.				+	+	+	+			+		+				+				
	Shioya Bay, Okinawa Is.				+			+			+						+				
	Shinsato, Okinawa Is.				+			+			+									+	
	Oyadomari Okinawa Is.										+		+				+				
	Yomitan Okinawa Is.							+			+										
	Sesoko Is. Okinawa Is.										+	+	+	+			+	+			
	Chinasaki, Okinawa Is.	+			+						+										
	Ohzima, Okinawa Is.	+			+						+						+				
	Aragusuku, Miyako Is.										+						+				
	Kubaka, Miyako Is.				+			+													
	Miyakuni, Miyako Is.										+						+				
	Ohura Bay, Miyako Is.				+						+						+				
	Kabira Bay, Ishigaki Is.	+	+		+			+			+										
	Sakieda, Ishigaki Is.		+		+			+			+						+				
	Ibaruma, Ishigaki Is.				+			+			+						+				
	Todoroki River, Ishigaki Is.				+			+			+										
	Shiraho, Ishigaki Is.				+						+										
	Miyara, Ishigaki Is.	+			+	+		+													
	Taketomi Is.						+	+			+						+				
	Kuroshima Is.														+						
	Sonai, Iriomote Is.				+	+	+	+			+		+		+						
Ogasawara Islands	Ohmura Beach, Chichizima Is.								+	+		+					+				
	Sakaiura, Chichizima Is.											+					+				
	Eboshiiwa, Chichizima Is.											+	+				+				
	Kanameishi, Chichizima Is.											+	+				+				
	Kominato, Chichizima Is.												+				+				
	Miyanohama, Chichizima Is.								+			+	+								
	Minamihatsuneura, Chichizima Is.												+								
	Takinoura, Chichizima Is.												+				+				

respectively from Izu Peninsula, Shizuoka Prefecture; from Kagoshima to Boso Peninsula; from Nagasaki; from Kagoshima north to Niigata on the coast of Japan Sea and to Tokyo Bay on the Pacific; from Kagoshima north to Toyama Bay on the coast of Japan Sea and to Miyagi Prefecture on the Pacific; from Kagoshima north to Toyama Bay on the coast of Japan Sea and to Misaki, Kanagawa Prefecture on the Pacific. The latter three species have been also recorded from Korea and the tropical waters of the West Pacific or the Indian Ocean. *Mahidolia mystacina* occurs, too, in the tropical West Pacific and the Indian Ocean. *Ctenogobius* sp. A, sp. B and sp. C, and *Amblyeleotirs japonicus,* reported from the Nasei Islands by Harada (1972), are affirmed to be *Ctenogobiops crocineus, Vanderhorstia ornatissima, Mars caeruleomaculatus* and *Amblyeleotris steinitzi,* respectively. The occurrences of the gobiid fishes at the various localities on the southern coast of Japan, observed by myself and some other workers from 1972 to 1976, are shown in Table 13.

Fairly remarkable differences in the species composition of the gobiid fishes are seen among three geographical areas; Honshu and Kyushu Area, the Nansei Islands, and the Ogasawara Islands. *Vanderhorstia lanceolata, Amblyeleotris japonica, Cryptocentrus filifer, Acentrogobius pflaumi* and *Vireosa hanae* occur only in Honshu and Kyushu Area, but the latter three species have also been recorded from the tropical waters as mentioned above. *V. lanceolata* and *A. japonica* seem, according to my knowledge, to be endemic to this area. Of twenty species, 15 species were found on the coastal water of the Nansei Islands, all of which, except four species newly described in this paper, have been already recorded from the tropical West Pacific or the Red Sea (Herre, 1933, 1936; J.L.B. Smith, 1959; Klausewitz, 1960, 1974a, 1974b). In the Ogasawara Islands, where the water temperatures are as high as those of the Nansei Islands and yet the coral reefs are not so developed, only five species, *Vanderhorstia mertensi, V. ornatissima, Tomiyamichthys oni, Amblyeleotris ogasawarensis* and *A. fasciata* were observed, all of which are also seen in the Nansei Islands or Hoshu and Kyushu Area.

The substratum and the ranges of water depth where the gobiid fishes were observed to occur in three geographical areas are summarized in Table 14. The substratum was roughly devided into four categories; mud, muddy sand, sand, and coral sand bottoms. "Sand bottom" includes that with gravels, shell fragments and coral rubble, and "coral sand" indicates the well-bleached sand made of corals and animals' remains around living corals. The bottom substrate where each gobiid fish inhabits is rather restricted and is nearly almost similar among the localities, and also each species seem to have its own preference to the depth of water. The followings are two instances of the distribution at Shirahama, Wakayama Prefecture and in Akasaki Reef, Yoron Island, where the most detail observations were done.

On the northern coast of the Seto Marine Biological Laboratory in Shirahama, seven species were observed. *Amblyeleotris japonica* which occurs most commonly from 2 m to 15 m depths lives in the burrows of *Alpheus bellulus* on the sand bottom with pebbles, shell fragments and coral rubble, and in the burrows of *A. rapacida* and *A.*

Table 14. Substratum and ranges of depth where gobiid fishes occur in coastal areas of southern Japan.

		SUBSTRATUM				DEPTH			
		Mud	Muddy-Sand	Sand	Coral-Sand	Inter-tidal	−5 m	−10 m	10 m−
Honshu and Kyushu Area	*Cryptocentrus filifer*	+						+	+
	Vanderhorstia mertensi	+	+					+	+
	Vanderhorstia lanceolata	+	+						+
	Tomiyamichthys oni			+			+	+	+
	Amblyeleotris japonica		+	+			+	+	+
	Mahidolia mystacina	+					+	+	+
	Acentrogobius pflaumi	+	+			+	+	+	+
	Vireosa hanae		+	+			+	+	+
Nansei Islands	*Cryptocentrus singapurensis*	+	+			+	+		
	Cryptocentrus flavus	+	+			+	+		
	Mars caeruleomaculatus	+	+	+		+	+		
	Mars nigrocellatus				+		+	+	+
	Mars albidorsus				+		+	+	+
	Vanderhorstia ornatissima	+	+			+	+		
	Vanderhorstia mertensi	+						+	
	Ctenogobiops crocineus			+	+		+	+	+
	Tomiyamichthys oni			+			+	+	+
	Amyleotris fasciata			+	+		+	+	+
	Amblyeleotris maculata			+				+	+
	Amblyeleotris guttata			+	+				+
	Amblyeleotris steinitzi			+	+		+	+	+
	Amblyeleotris ogasawarensis			+	+				+
	Mahidolia mystacina	+					+	+	
Ogasawara Islands	*Vanderhorstia ornatissima*	+	+			+	+		
	Vanderhorstia mertensi		+				+	+	
	Tomiyamichthys oni		+	+			+	+	+
	Amblyeleotris fasciata			+	+		+	+	+
	Amblyeleotris ogasawarensis			+	+		+	+	+

bellulus on muddy sand bottom where *Zostera marina* and *Halophia ovalis* are occasionnally grown. *Cryptocentrus filifer* occurs in the burrows of *Alpheus* sp. on mud bottm usually more than 20 m depth. *Tomiyamichthys oni* occurs on nearly the same substratum and depth as *A. japonica,* and takes in association with *A. bellulus. Acentrogobius pflaumi* lives in the shallow water less than 5 m depth and sometimes takes in association with *A. bellulus* on the muddy sand bottom. This species is abundantly seen on the shallow mud bottom in the head of Tanabe Bay sometimes associating with *Alpheus brevicristatus. Vireosa hanae* hover above the submerged rocks and the sand bottom, and use the burrows made by *A. bellulus* and occupied by *A. japonica* as often as the rock crevices and the undersurfaces of stones at 3 m to 10 m depths. *Vanderhorstia mertensi* and *Mahidolia mystacina* are seen in the burrow of *A. rapacida*

on the mud or muddy sand bottom of 5 m to 20 m depths. Two gobies of *V. mertensi* and *A. japonica* and two shrimps of *A. belelus* and *A. rapacida* are often observed to inhabit together on the muddy sand bottom. Although *A. japonica* takes in assocation with both of the shrimps, *V. mertensi* seems to associate only with *A. rapacida.*

In Akasaki Reef, Yoron Island, seven species occur. *Ctenogobiops crocineus* is the most abundant on the sand bottom with coral rubble and shell fragments on reef flat which extends about 1 km to the reef edge, ranging from 1 m to 4 m in depth. *Amblyeleotris steinitzi,* which is not so abundant as *C. crocineus,* occupies nearly the same substratum and depth as the latter. On the muddy sand bottom protected by rocky protrusions shallower than 2 m in depth, *V. ornatissim* and *M. caeruleomaculatus* dominantly occur. *Amblyeleotris fasciata* is found sympatrically with *C. crocineus* and *A. steinitzi* on sand bottom, and also intrudes into the bottom composed of well-bleached coral sand surrounded by living corals. Two rare species *Mars nigrocellatus* and *M. albidorsus* also inhabit on the sand bottom, and their occurrences are almost restricted in the burrow dug by the certain species of the snapping shrimp under the fringes of dead coral. There is apparently some specificity in combinations between the gobiid fishes and the snapping shrimps, but only few knowledges on this specificity have been obtained as most of the shrimp species in the Nansei Islands have not been collected and identified.

Consideration

The differences in the nature of the interrelationship with snapping shrimps and the ways of utilizing their burrows are clearly recognizable among symbiotic gobiid fishes in Japan, and, with these respects, these fishes can be distinguished into three groupings.

(1) *Vireosa hanae* represents one category, that hovers above the bottom and uses rock crevices or rooms beneath stones as sheltering places as often as it utilizes shrimp's burrows. This species has never been observed to engage in the tactile alarm system with snapping shrimps. This mode of life is similar to that of *Lotilia graciliosa* reported from the Red Sea (Klausewitz, 1960).

(2) In the case of *Acentrogobius pflaumi,* a bottom dweller, the establishment of a tactile alarm system with snapping shrimp is unsuspectedly exhibited, but its association with shrimp's burrows seems rather weak, arbitrary and facultative. It quite frequently happens that, while it is staying at the entrance of a shrimp's burrow, this fish does not take retreat into the burrow but swims away to flee from a diver approaching to it.

(3) Other 18 species treated in this paper are all bottom dwellers and fall in the third category. They usually utilize burrows of snapping shrimps as sheltering place and have developed a tactile alarm system. In the case of *Vanderhorstia ornatissima,* all the members of the population observed in Yoron Island were in the intimate association with shrimps, but in Chichi-zima Island some members of the population were seen staying on the sand bottom without making any contact with shrimp's bur-

rows and sometimes were observed to take flight by swimming over the bottom, not retreating into shrimp's burrows, as it is in a case of *A. pflaumi*. Similarly, slight differences in the degree of dependence on shrimp's burrow have been noticed in other species among localities.

Gobiid species treated here as found being in association with snapping shrimps are varied taxonomically. The genus *Vireosa* is closely related to *Ptereleotris*, having more than 20 second dorsal soft rays and 4 pelvic soft rays, but is far apart taxonomically from other genera concerned. The genus *Acentrogobius* is also placed quite apart taxonomically from other genera. This genus includes common gobiid species on the sandy or muddy bottom, i.e. *pflaumi, ornatus, campbelli, cringer, gymnauchen*, etc., but only *A. pflaumi* is known to get the habit of using the shrimp's burrow. The genus *Mahidolia* which is characterized by the elongated maxillae in male occupies the peculiar taxonomical position and is not close to other genera.

Other six genera treated in this paper, i.e. *Cryptocentrus, Mars, Vanderhorstia, Ctenogobiops, Tomiyamichthys* and *Amblyeleotris*, resemble each other and have many common morphological characters: head naked, interorbital space very narrow, snout about as long as eye diameter, scales minute and more than about 50 in a longitudinal series, scales ctenoid in front and cycloid posteriorly or all cycloid, teeth on both jaws in two or more series, tongue rounded or truncate, gill opening wide or moderate, caudal fin about as long as or longer than head length. *Amblyeleotris* was formerly included in the family Eleotridae as having separated pelvic fins, it has been pointed out now that this genus is related more closely to Gobiidae, and separation of its pelvic fins is considered to have occurred secondarily in its phylogeny (Yanagisawa, 1976). Other characteristics of *Amblyeleotris* are very close to those of *Cryptocentrus*. Between *Mars* and *Cryptocentrus*, no essential differences are found besides rather trifle differences: well-developed sensory papillae on head in the former against poorly defined one in the latter. *Tomiyamichthys* is the genus newly devided from *Cryptocentrus* after J.L.B. Smith's (1956) proposition, as has been mentioned elsewhere. *Vanderhorstia* and *Ctenogobiops* are barely distinguishable from *Cryptocentrus* by fewer number of scales and elongated body, and fewer number of scales and a little pointed snout, respectively. Those close similarities among six genera seem to suggest that they are building up one group in the family Gobiidae.

As far as I know, all of the species belonging to the genera *Mars, Vanderhorstia, Ctenogobiops, Tomiyamichthys* and *Amblyeleotris*, whose ecology are known from any part of the world, are living in association with snapping shrimps. Genus *Cryptocentrus* comprises more than 30 species and it is not certain whether all these species are taking up the partnership with the shrimps, although those who have ever been observed underwater are all in association with snapping shrimps. Thus, it is obvious that the habit of living with snapping shrimps is quite widely adopted among bottom-dwelling gobiid fishes, perhaps because it is effective and advantageous for them to utilize the burrows of snapping shrimps on the flat sandy or muddy bottom where few shelters are available for them unless the gobiid fishes dig burrows by themselves. On the other hand, however, the existence of snapping shrimps in the

habitat means more than beneficial condition and, for some of these species, may have become an essential prerequisite to maintain their lives, perhaps the gobiid fishes be in turn for some of the snapping shrimps as well. It may be probable that the distribution of these gobiid fishes has been extended or restricted and the speciation of them has been prompted through the acquirement of the habit of dwelling in the shrimp's burrow.

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EXPLANATION OF PLATES I—III

PLATE I

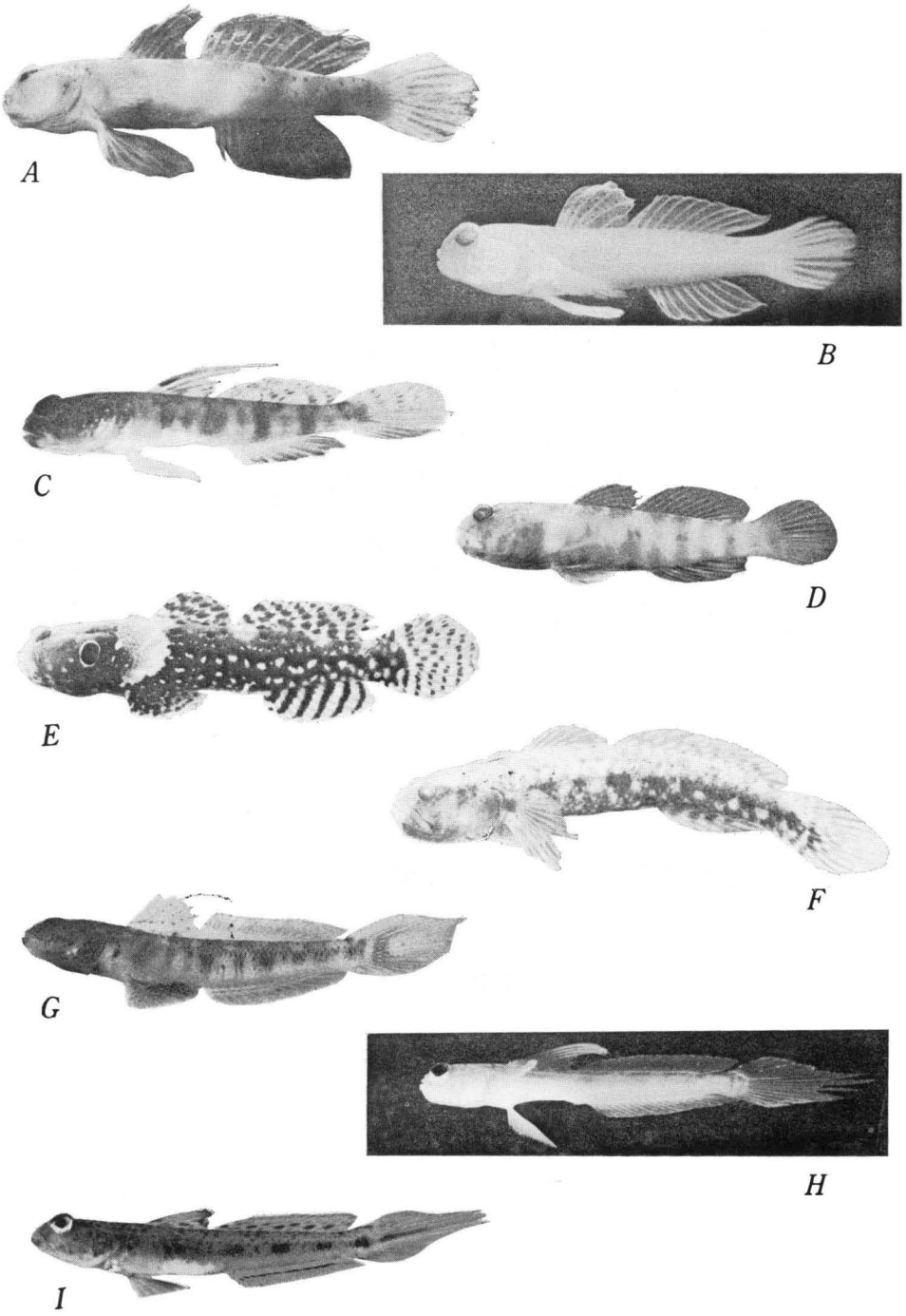
Specimens of gobiid fishes associated with snapping shrimps.
A: *Crpytocentrus singapurensis*; B: *Cryptocentrus flavus*; C: *Cryptocentrus filifer*; D: *Mars caeruleomaculatus*; E: *Mars nigrocellatus*; F: *Mars ablbidorsus*; G: *Vanderhorstia ornatissima*; H: *Vanderhorstia mertensi*; I: *Vanderhorstia lanceolata.*

PLATE II

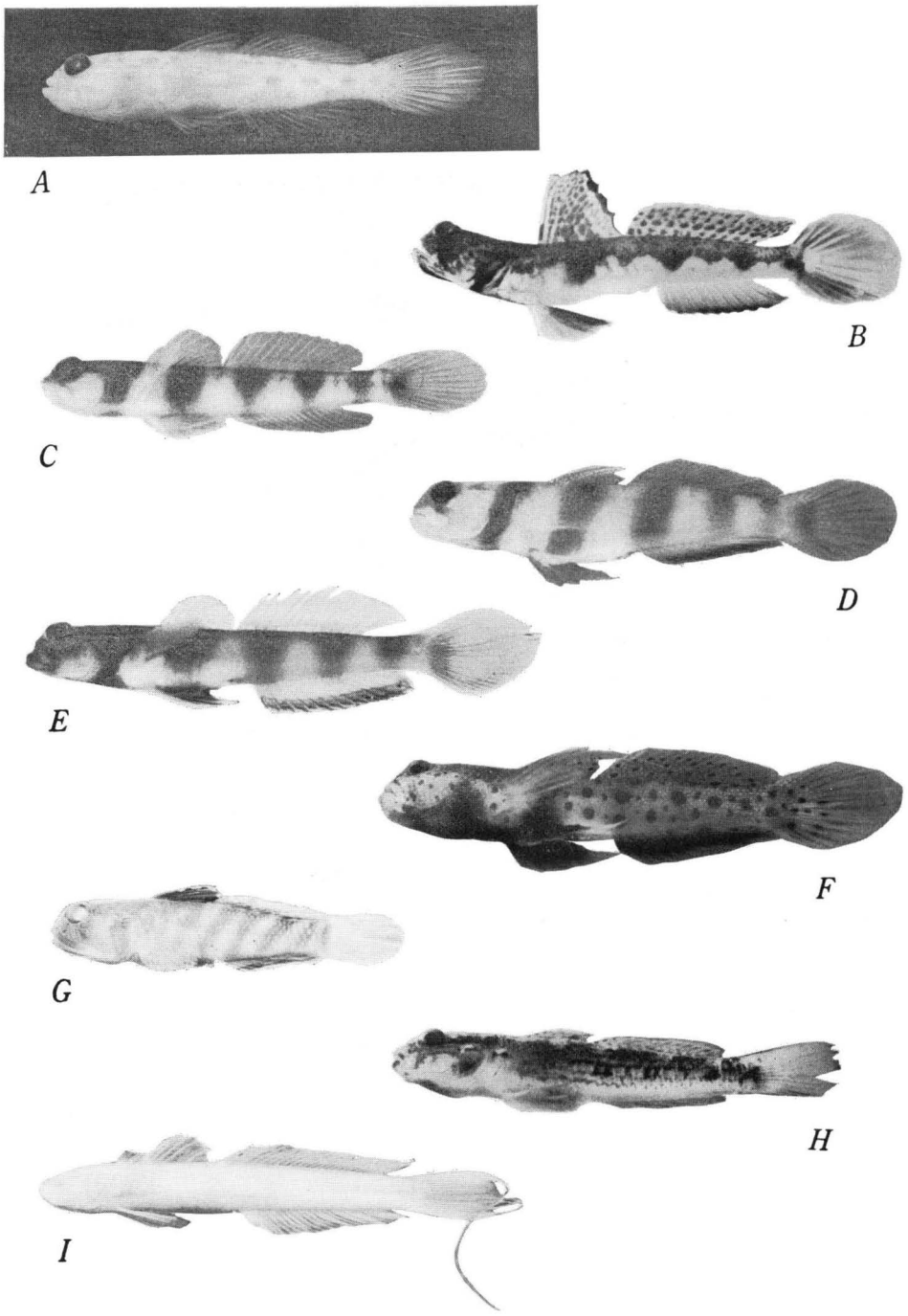
Specimens of gobiid fishes associated with snapping shrimps.
A: *Ctenogobiops crocineus*; B: *Tomiyamichthys oni*, reproduced from a transparency taken by C. Araga; C: *Amblyeleotris japonica*; D: *Amblyeleotris steinitzi*; E: *Amblyeleotris ogasawarensis*, reproduced from a transparency taken by T. Yoshino; F: *Amblyeleotris guttata*; G. *Mahidolia mystacina*; H: *Acentrogobius pflaumi*; I: *Vireosa hanae.*

PLATE III

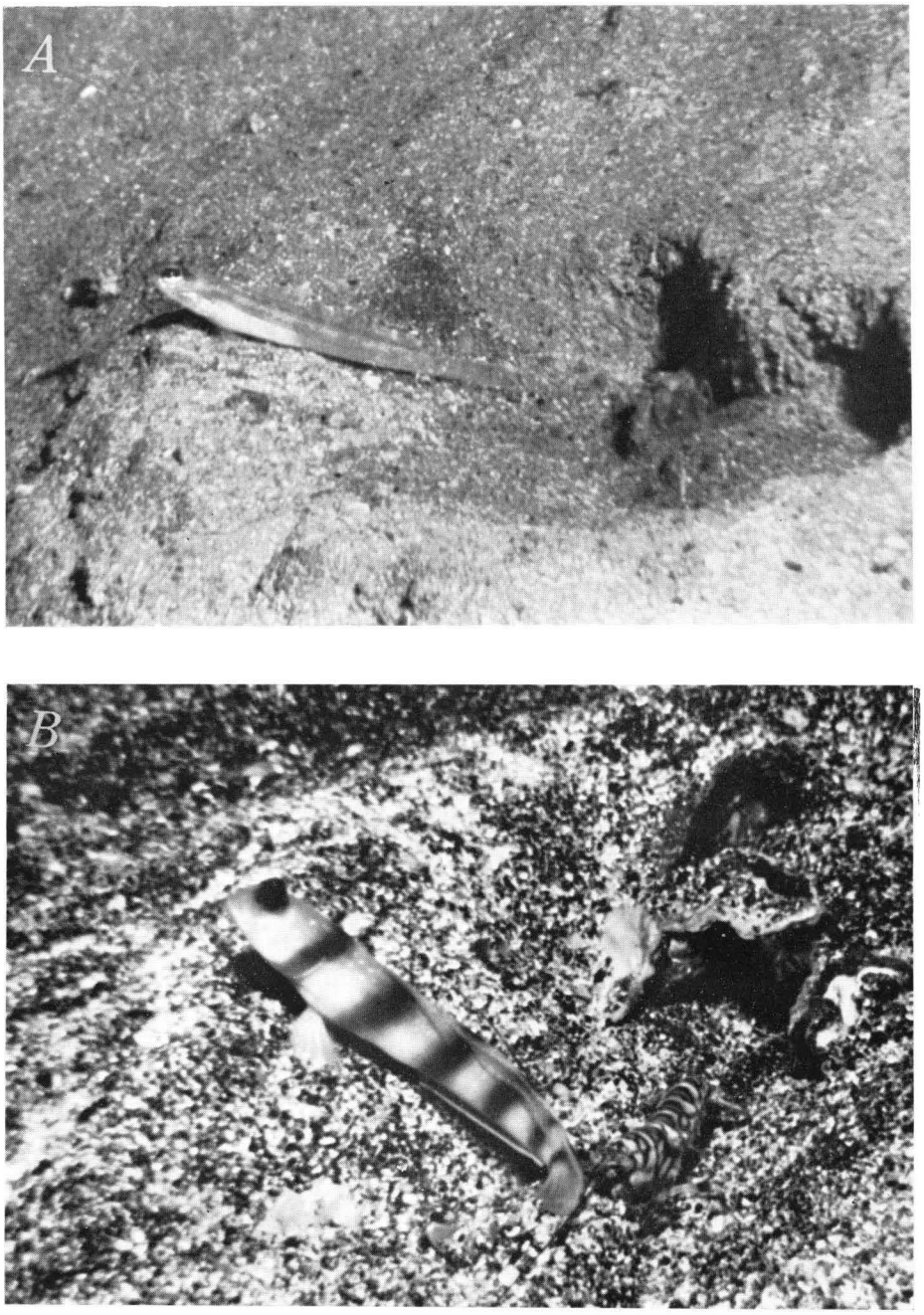
A: *Vanderhostia mertensi* with *Alpheus rapacida.* Photo by H. Usuki.
B: *Amblyeleotris japonica* with *Alpheus bellulus.* Photo by K. Nakamura.



Y. YANAGISAWA: *Gobiid Fishes Associated with Snapping Shrimps*



Y. YANAGISAWA: *Gobiid Fishes Associated with Snapping Shrimps*



Y. YANAGISAWA: *Gobiid Fishes Associated with Snapping Shrimps*